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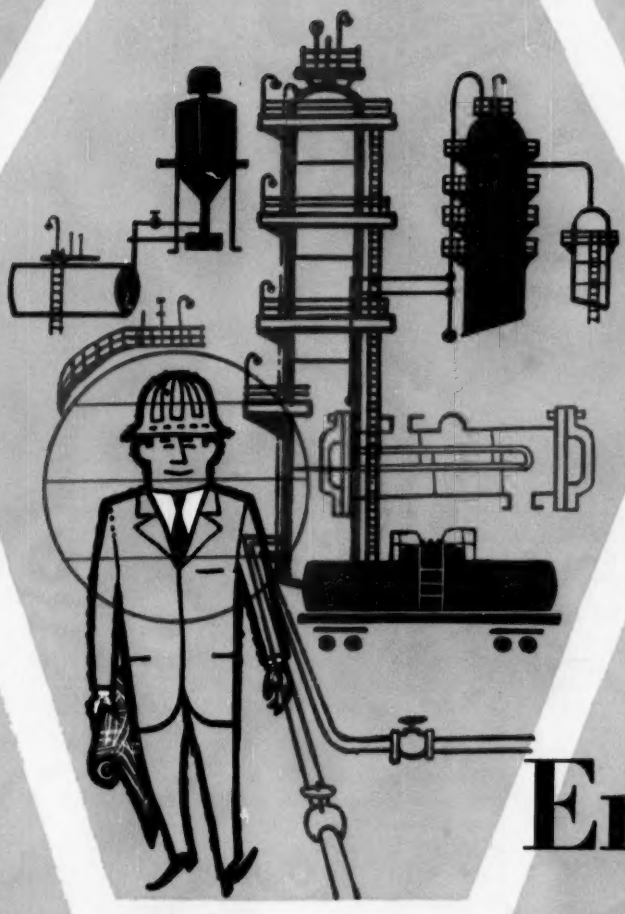

Systems Engineering

...Promises Fat Dividends in

PLANT DESIGN

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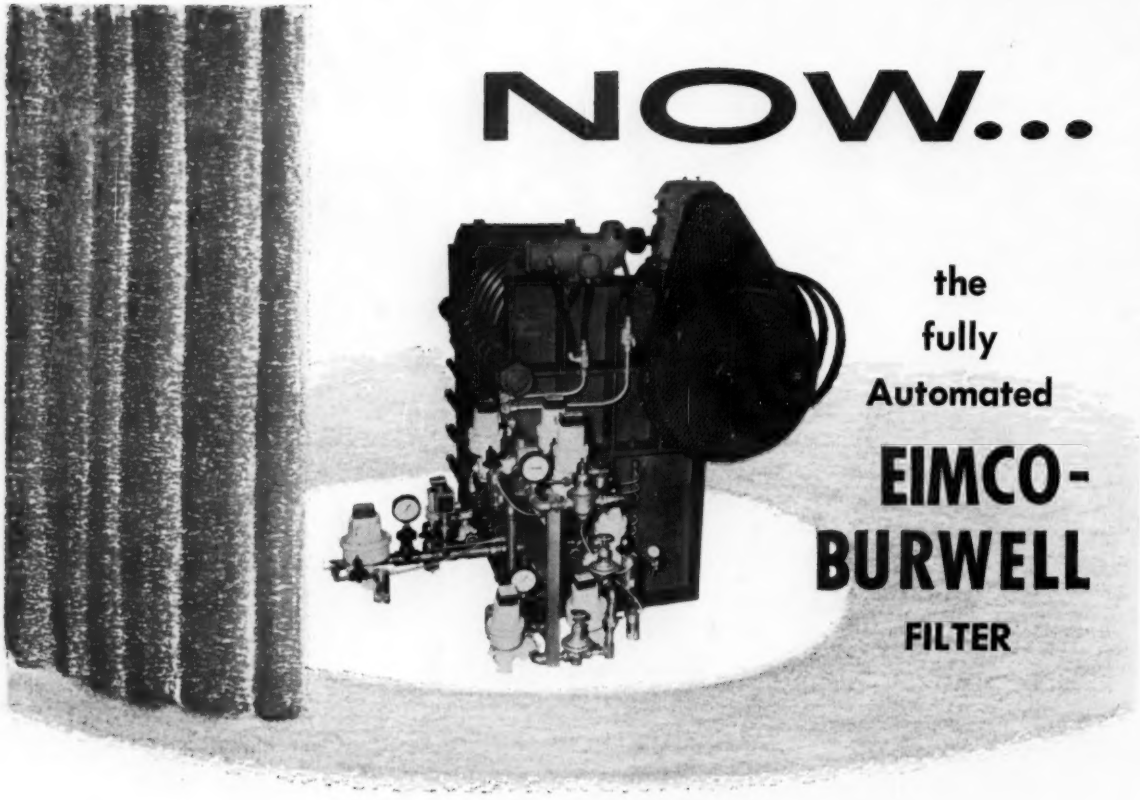


NOW...

the fully Automated

EIMCO-BURWELL FILTER

Starts its own Cycle ...Completes Cycle ...Starts Over – Automatically!

Another Eimco achievement in the development of equipment for liquid-solids separation is the Eimco-Burwell filter shown above. Built for a separation process involving the recovery of a valuable metal, this is the first plate and frame filter capable of completely automatic operation.

The filter is equipped with an electric timing control circuit and all auxiliaries for automatic operation on a multi-cycle basis. No operator attention is required once the controls are set. Opening and closing of frames . . . fill . . . wash . . . blow . . . rotation — all fully automatic.

The automated Eimco-Burwell represents the end result of thousands of hours of development work by Eimco engineers. It represents, too, the elimination of high labor costs commonly associated with the operation of plate and frame filter presses.

The Eimco-Burwell is unequalled by any filter for washing out the highest percentages of soluble values from the cake, or for producing a filtrate containing an absolute minimum of contaminants. It can handle materials of widely varying characteristics, including viscous slurries.

For more details, get in touch with the Eimco representative in your area. Or, write the Eimco Filter Division for Bulletin F - 2052.

"ADVANCED ENGINEERING AND QUALITY CRAFTSMANSHIP SINCE 1884"

THE EIMCO CORPORATION

EXPORT OFFICE: 51 - 52 SOUTH STREET, NEW YORK, N. Y. B - 548
BRANCHES AND DEALERS IN PRINCIPAL CITIES THROUGHOUT THE WORLD

FILTER DIVISION
634 SOUTH 4TH WEST
SALT LAKE CITY, UTAH — U.S.A.

RESEARCH AND DEVELOPMENT CENTER
301 SO. HICKS ROAD, PALATINE, ILLINOIS

Photo courtesy of Plastics & Coal Chemicals Division, Allied Chemical & Dye Corporation, Ironton, Ohio

Hose bends over backwards to do a good unloading job

WORKERS at a southern Ohio chemical plant were having a terrible time unloading carbolic oil through metal tubing. Making the connection from river barge to pump was a chore—the tubing was heavy, hard to maneuver, a strain to connect. It couldn't take sharp angles or stand much bending. Sometimes the metal hose would spring a leak after only a few hours' service.

After discussing the problem with a B.F.Goodrich man, the company decided to try a rubber hose which BFG built specially for the job. A continuous spiral of round spring steel wire within the hose was used to add strength, increase crush resistance, prevent collapse under vacuum.

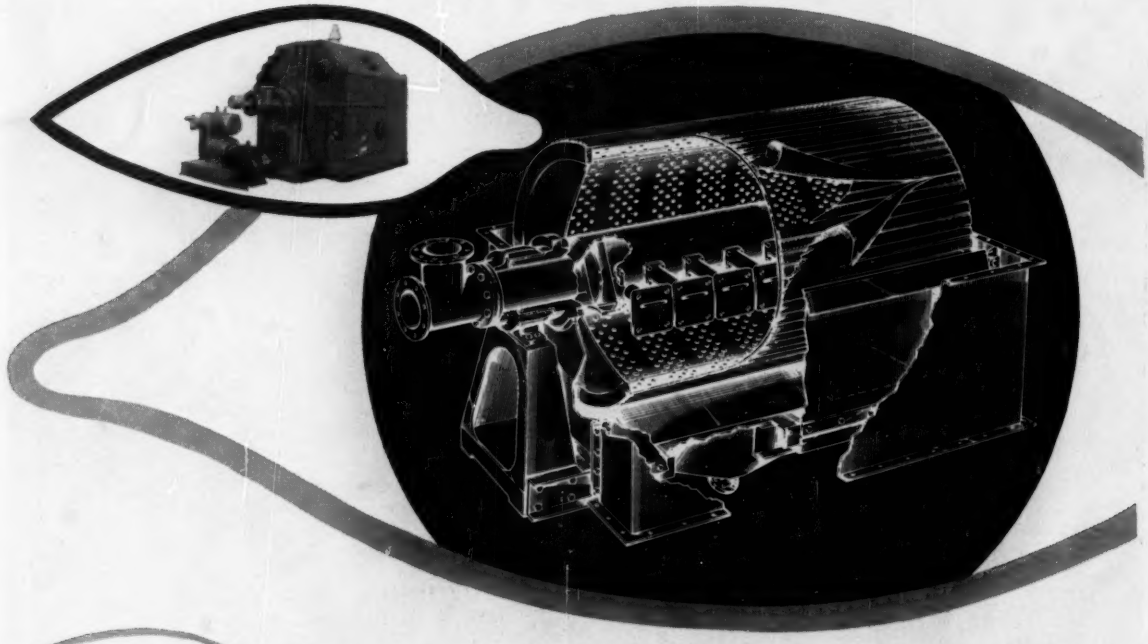
You can see for yourself how flexible the hose is. Even though bent at a sharp angle, the BFG hose doesn't kink or buckle. It adjusts easily to the movement of the barge. Inside, the hose lining is oilproof. And for protection against rough dock service, the hose cover is made of a tough rubber compound that resists abrasion, weather, sun.

At last report, the B.F.Goodrich hose had been in service a little over eight months, had needed no maintenance, was still in good shape. It had put an end to the mess of oil leaks and the cost of frequent tubing replacements.

Your B.F.Goodrich distributor has full information on this particular hose. And, as a factory-trained specialist in rubber products, he can answer your questions about the many rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-836, Akron 18, Ohio.*

B.F.Goodrich

When Your Filtered Solids Need a Good Wash . . .



look into this

BIRD-YOUNG

Rotary Drum

VACUUM FILTER

Design of the Bird-Young Filter permits location of pan directly under the wash area. Sharp separation of wash liquors from the filtrate and from each other is positively assured.

Construction of the Bird-Young Filter permits operation at optimum drum speed with relatively thin, permeable cakes. Amount of wash water is therefore not limited.

OTHER ADVANTAGES OF BIRD-YOUNG DESIGN AND CONSTRUCTION INCLUDE:

- **extraordinary throughput of solids per foot of filter area:** often this means a small filter instead of a big one, or one instead of two
- **ability to handle big volumes of filtrate** since flow is completely unrestricted — no internal piping
- **totally enclosed, tightly sealed operation** is readily and inexpensively effected

Check washing efficiency and separating efficiency in advance. The Bird Research and Development Center's unsurpassed pilot-scale test facilities are at your disposal.

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May 2, 1960 **Chemical Engineering** Vol. 67 No. 9

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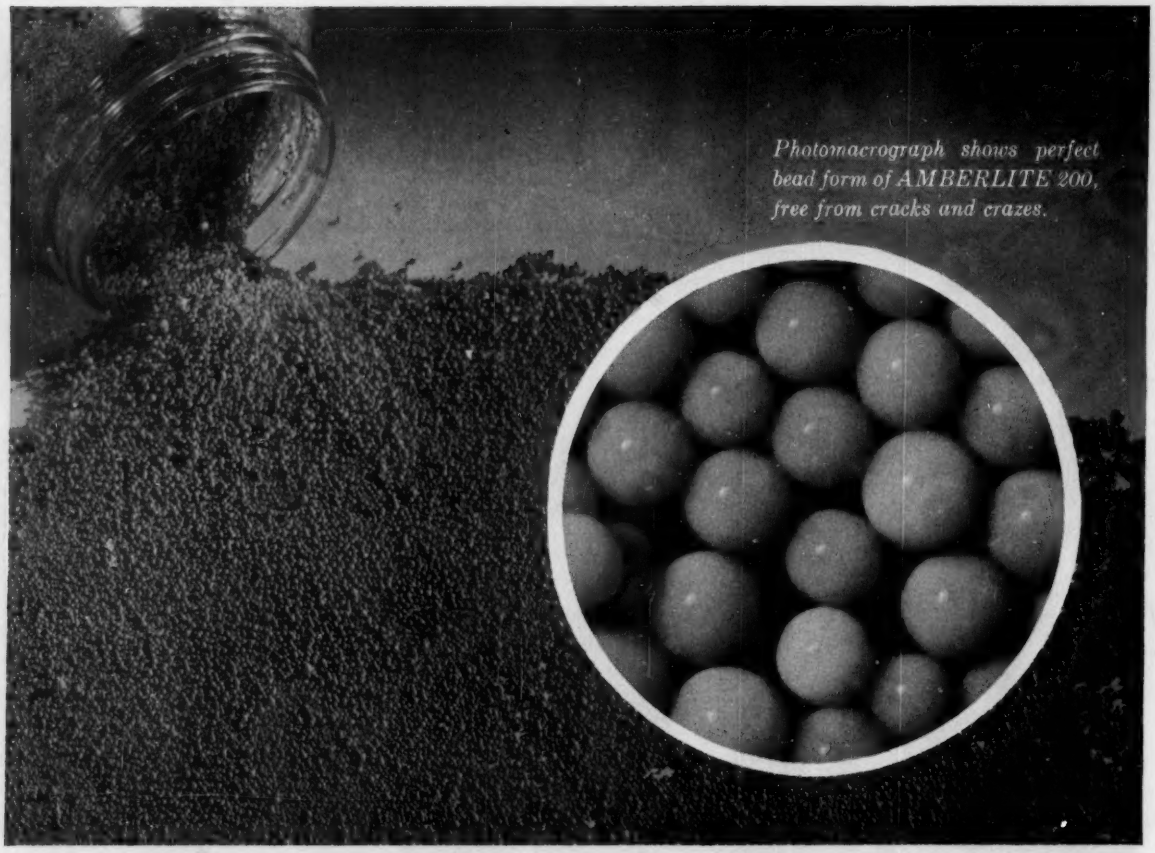

Photomacrograph shows perfect bead form of AMBERLITE 200, free from cracks and crazes.

AMBERLITE 200

Introducing new durability for Ion Exchange Resins

AMBERLITE 200 represents an entirely new concept in polymer chemistry. A high capacity, strongly acidic cation exchange resin, AMBERLITE 200 has physical and chemical stability unmatched by any available cation exchange resin.

These are some of the outstanding features of AMBERLITE 200 . . . *high resistance to oxidation,* especially in water containing chlorine, oxygen and metals such as iron, copper and manganese; *perfect bead form,* free of cracks and crazes; *high attrition resistance; stability over the entire pH range; insolubility in all common solvents.*

In addition to water treatment in either hydrogen or sodium cycle operation AMBERLITE 200 has unusual value in the treatment of highly concentrated solutions such as sucrose and glucose, where resin dehydration causes rapid failure of conventional exchangers. Resistance to oxidation makes AMBERLITE 200 useful in treatment of highly aggressive solutions such as chromic acid or where high operating temperatures are involved.

Write for full information and samples on this radically new AMBERLITE resin.

AMBERLITE is a trademark, Reg. U.S. Pat. Off. and in principal foreign countries.

Chemicals for Industry

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

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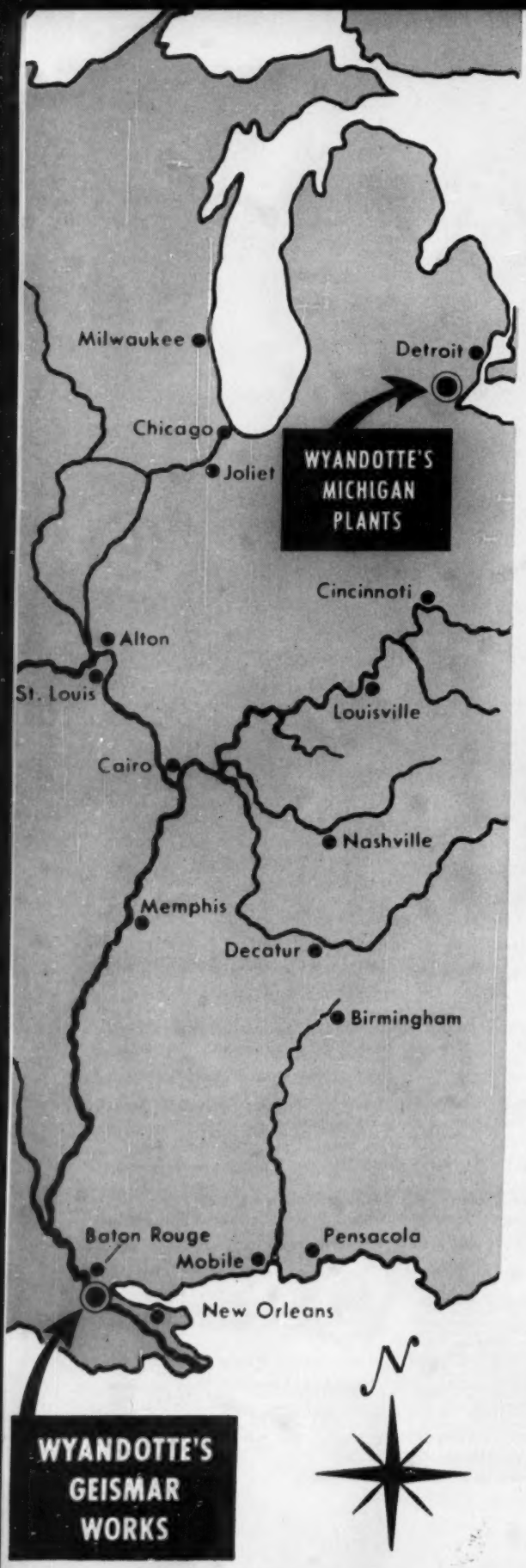


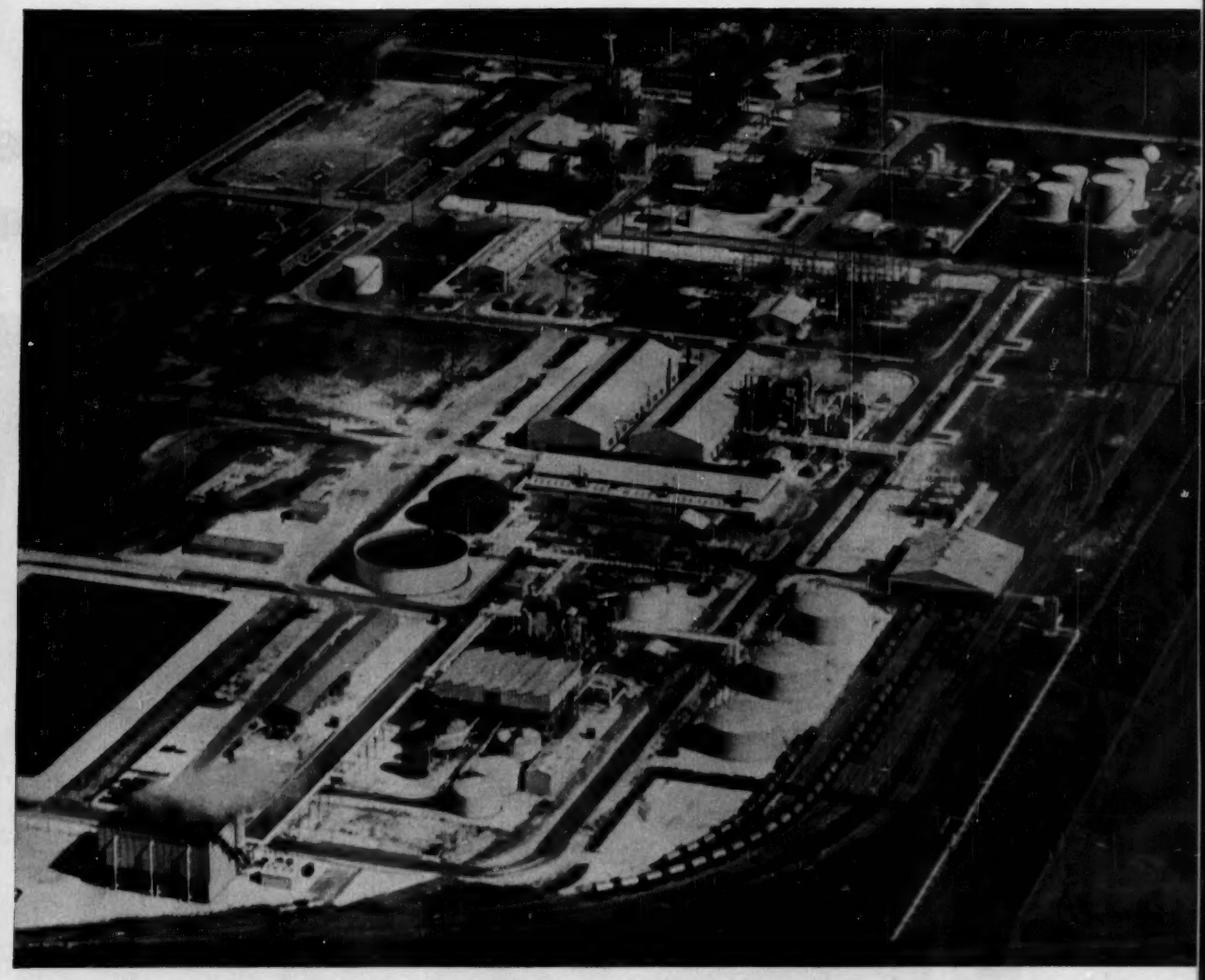
Something

Wyandotte's decision to produce chlorine and caustic in the South, as well as in the North, is proving its worth to a growing number of users of these two key chemicals. Can you benefit?

May we direct your attention to the map at the left? It illustrates an important point about our two chlorine-caustic plants. *Both are on major waterways.*

At Geismar, in the South, we are on the Mississippi . . . and close to the Gulf. At Wyandotte, in the North, we have direct access to the Great Lakes and the St. Lawrence Seaway.

Add to this the fact that railways and highways also go out from these two plants to four-fifths of the



Aerial view shows Wyandotte's new, modern Geismar Works immediately south of Baton Rouge, Louisiana. The chlorine-caustic facility is in the foreground. Ethylene oxide and ethylene glycol facilities are in the background.

ventured . . . something gained

productive capacity of the U. S. and Canada, and you see quite readily why more and more users of chlorine and caustic are taking advantage of our ability to ship economically and with dispatch . . . by barge or ocean tanker, truck or tank car. Can you benefit? We'd like to discuss the possibilities with you. *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

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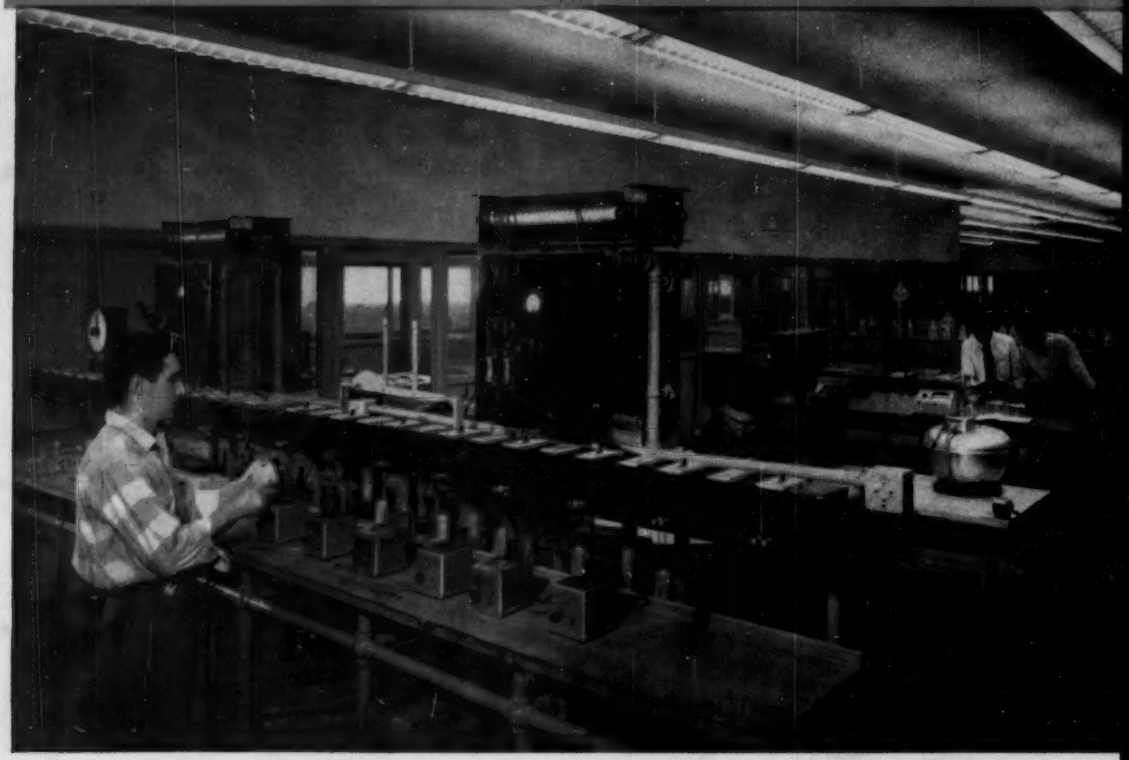
How lasting quality is Heat Exchanger

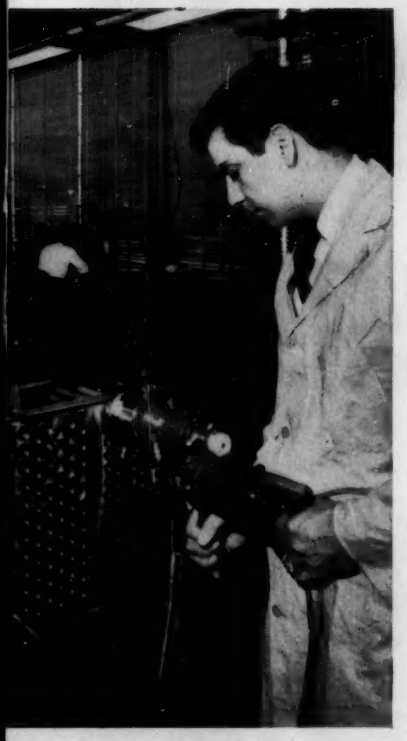
5 ENGINEERING RESEARCH

(FIFTH OF A FIVE-PART SERIES)



Engineering research at new Phelps Dodge mill in South Brunswick, N. J., includes many types of laboratory tests aimed at improving quality control, providing longer tube life.

built into Phelps Dodge and Condenser Tubes...



Recent technical advances pioneered in Phelps Dodge laboratories include tube to tube sheet welding.

More than 40 years of continuing engineering research and manufacturing experience lie behind the lasting quality and long service life of Phelps Dodge heat exchanger and condenser tubes. This vast background has constantly made new contributions to the industry. Phelps Dodge pioneered the manufacture of long length tubes, Dual-gauge tubes and bell-end tubes, keeping pace with the changing designs of heat transfer equipment. Phelps Dodge also has an established reputation as a specialist in the manufacture of duplex tubes, fluted tubes and U-bend tubes.

The Phelps Dodge research staff of chemists, engineers and metallurgists combine their skills on all kinds of tube problems. By analyzing and evaluating the key factors—water pollution, acidity, corrosion, temperature variation effects and other conditions that vitally affect tube performance—they suggest the alloy best suited for particular operating conditions.

This valuable "know-how" goes beyond laboratory analysis and alloy specifications. It is applied to increasing tube service life through ever closer control of quality and to improvement of fabricating and testing equipment. Special non-destructive tests, including eddy current, dye penetrant and ultrasonic inspections, are examples of the latest testing developments used by Phelps Dodge.

Throughout the entire tube fabricating operation—from raw materials to finished product—quality is the keynote. That's why Phelps Dodge tubes are preferred by those who demand the finest . . . the manufacturers and users of heat exchangers and condensers.

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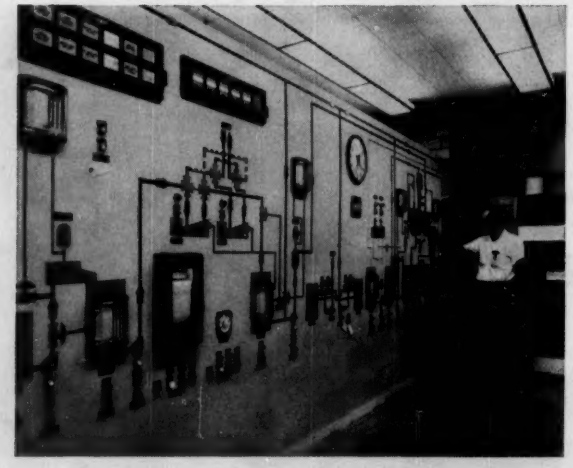
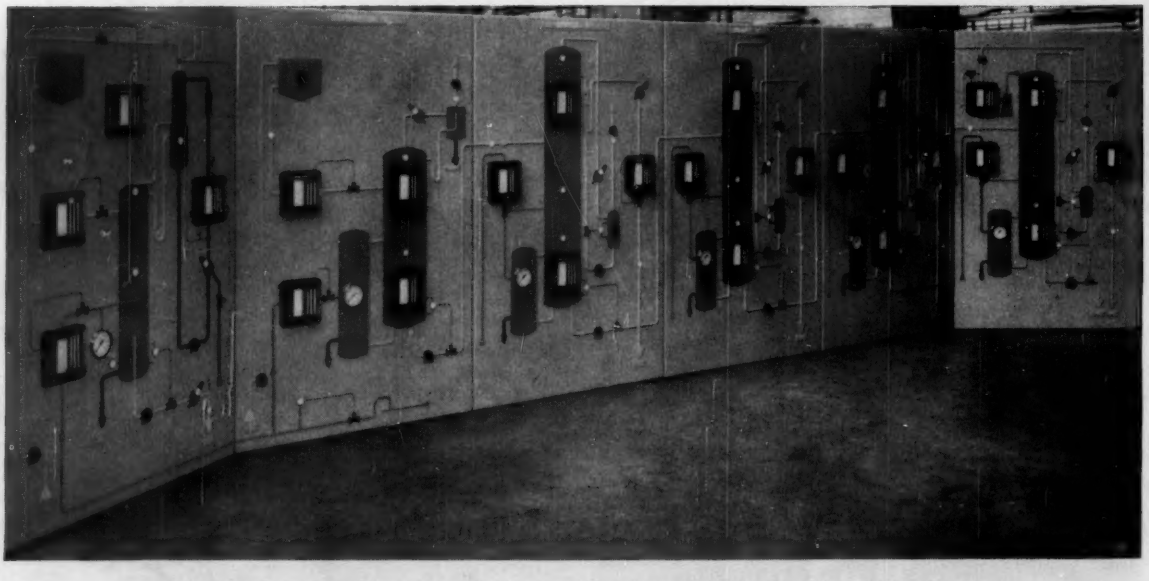
One of several TRANSCOPE panels in a large petrochemical plant in the South West.



Part of an extensive TRANSCOPE installation in a famous southern paper mill.

"FINEST OPERATOR'S



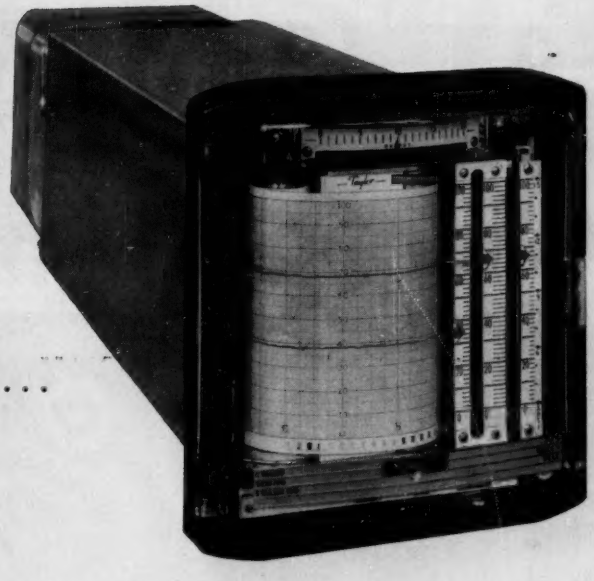
TRANSCOPE Recorders on a graphic panel in a benzol distillation plant in England.

Taylor Instruments

No other recorder

puts so many features

in so little panel space . . .



TOOL YET DEVELOPED"

The Taylor TRANSCOPE® Recorder

It is now generally recognized throughout industry that the Taylor TRANSCOPE (90J) Pneumatic Recorder is the finest ever built for modern miniature-instrument panels. Of equal importance, if you're in the market for such instrumentation, the 90J will not be obsoleted for many years to come. In fact user reports, after two years of field service, are so outstandingly complimentary that we believe the name TRANSCOPE will rival that of the now famous 20-year-old Taylor FULSCOPE* line for obsolescence-free dependability. Here are some of the reasons why the 90J is going to be the most imitated recorder:

Servo-Operated Pens with 150 times greater power, assure unprecedented accuracy of records.

Unconfused Readability because chart record, pen and set-point are side-by-side. Target-type pens and pointers are easiest to see, particularly at a distance. 4" chart reads from left to right on rectilinear coordinates.

Optional Front-of-Panel Settings let you make control adjustments easier, quicker and better . . . from the front of panel . . . while recording!

Stays on Automatic Control while the plug-in recorder slide is removed for inspection, providing continuous fully automatic control.

Complete Indicating Control Station while recorder is removed. Optional switch lets horizontal gage at top of recorder show either process variable or output to valve.

Receives Three Variables to be recorded or indicated; unique, plug-in Set Point Transmitter allows continuous control. Available with Process Alarms with Memory Pointers; Automatic-to-Manual switching; Cascade or Process-output Switch, and many other features . . . all in one compact case.

*Reg. U.S. Pat. Off.

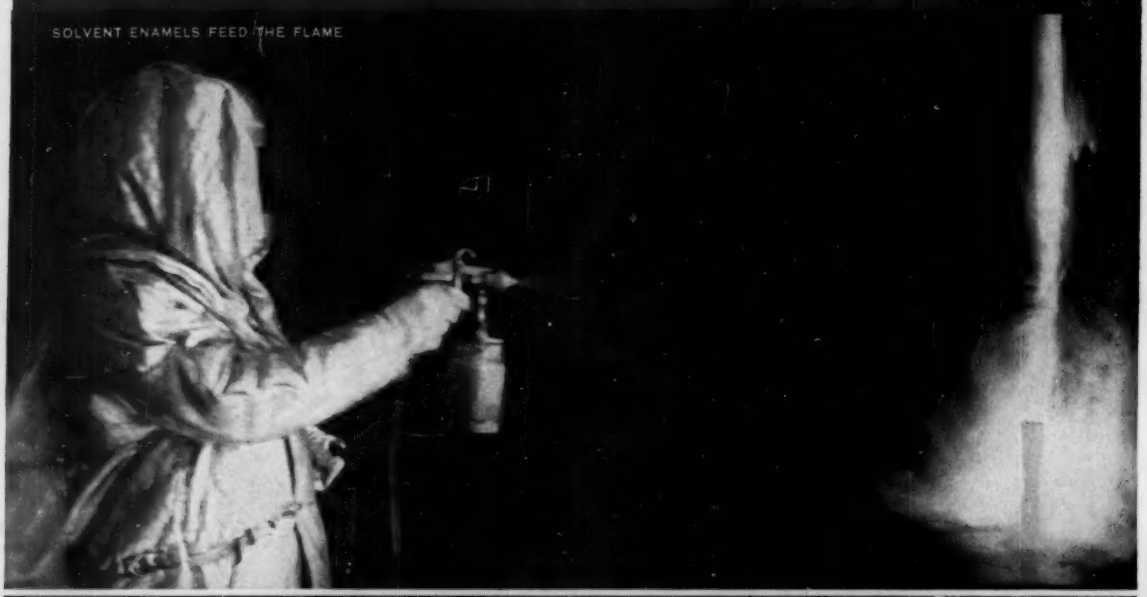
See your Taylor Field Engineer, or write for **Catalog 98286.**

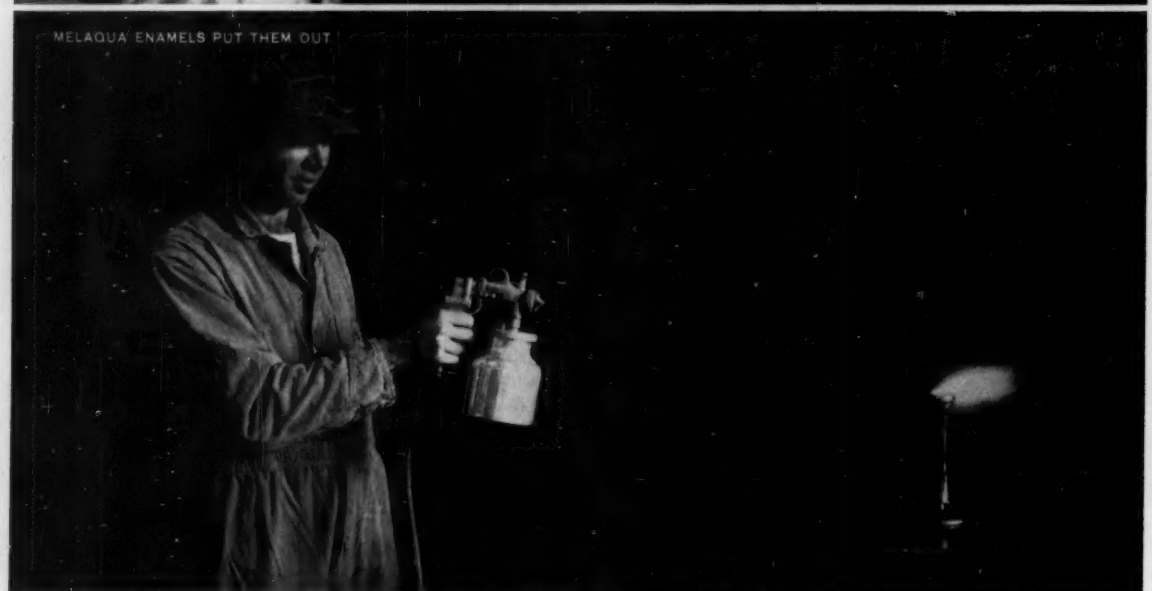
Taylor Instrument Companies, Rochester 1, New York, and Toronto, Ontario.

MEAN ACCURACY FIRST

CYANAMID

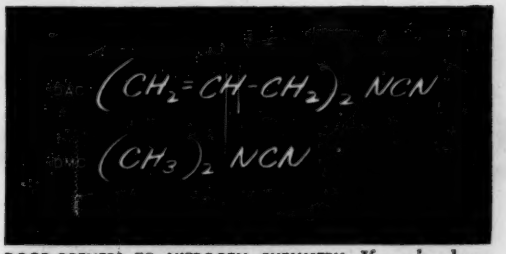
Chemical Newsfront





EXCITING NEW VEHICLE FOR BAKING ENAMELS is Cyanamid's MELAQUA* 600. This new product is a melamine-acrylic resin that produces a ready-to-spray enamel with only the addition of pigment and water. By excluding the use of solvents, Melaqua 600 completely eliminates fire hazards (see photos above). In addition to its safety factor, it gives the enamel such desirable qualities as exceptionally good flow and levelling, high gloss, and clearer, brighter colors than solvent enamels of the same pigmentation. Melaqua 600 enamels retain colors well under heat and light, have outstanding outdoor durability. Suggested uses for this new resin are full color, pastel metallescent industrial and automotive finishes.

*Trademark (Plastics and Resins Division)



DOOR-OPENERS TO NITROGEN CHEMISTRY. If you've been looking for a way to participate in the promising field of nitrogen chemistry, DIALKYL CYANAMIDES will prove helpful. Drum quantities of these compounds are available for the synthesis of substituted guanidines, biguanides, normal and isoureas, thioureas and secondary amines. Copolymers of *diallyl cyanamide* can be used as plasticizers, adhesives, molding, casting, and laminating resins, and for electrical insulation. *Dimethyl cyanamide* has unusual solvent properties – may also be used for hydraulic fluids and as a corrosion inhibitor.

(Market Development Department)

GOOD NEWS FOR RUBBER PROCESSORS. Natural, SBR and nitrile rubber products can now be manufactured more efficiently and economically – thanks to the excellent dispersibility of Cyanamid's new MBTS ACCELERATOR. The new MBTS makes possible such process savings as: shorter mixing cycles, lower reject rates, better dispersion, elimination of refining and master-batching. Its vulcanization and accelerating characteristics remain unchanged. Factory trials indicate that rubber processors get better and more uniform dispersion within the time cycle currently used for mixing. New MBTS is a high purity, light color product. **(Rubber Chemicals Department)**

NEW CATALYST TAKES THE FIELD. Cyanamid's new fluid cracking catalyst, AEROCAT® 3C*, is now undergoing extensive testing in the field. Composed of silica, alumina and magnesia, the new catalyst is designed for more flexible and profitable refinery operation. Its advantages over current silica-alumina compositions: yields more gasoline, more propylene and more butylene – produces less coke and dry gas. Aerocat 3C is available in two forms: Aerocat 3C-12 for high gasoline yield; Aerocat 3C-20 for high propylene and butylene yields.

******Patent applied for.* **(Industrial Chemical Division)**

CYANAMID

AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

All wool "Enchantress"—one of those heavenly carpets by Lees.

MORE AND LOVELIER CARPET COLORS. Here's good news for the carpet industry and its consumers: Cyanamid's new CALCO® LEVELING SALT LV eliminates objectionable striped or Barré effects encountered in dyeing wool carpeting – permits carpets to be dyed effectively in the widest range of colors ever! The agent also is expected to prove equally advantageous in dyeing nylon carpeting, hosiery and sweaters. When used with neutral dyes, Calco Leveling Salt produces deeper, level, solidly dyed shades on wool and/or nylon stocks, yarns and fabrics. Cyanamid's new agent allows the colorant to dye rather than stain the fiber. As a result, shades may be matched by adding color in process – not possible with other agents of this type. Calco Leveling Salt has no adverse effect on the fastness of the dyes used. **(Dyes Department)**

For further information on products in this advertisement wire, phone – or mail this coupon to:

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"A new bag for

"PROBABLY

"These PE bags

"WHAT'S THE

Here's the story on new St. Regis CAPCOTE* PE bags... better moisture-barrier performance at reduced cost!

This is the bag! No other.

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Capcote PE assures you of the most effective product protection . . . economically. Capcote PE lets you upgrade your bag specifications by replacing less efficient moisture-barrier sheets with superior moisture-resistance. Capcote PE makes your bag choice simpler. Instead of buying by weight, you determine the de-

you...improved PE!"

COSTS MORE!"

cost less!"

STORY?"

gree of moisture-resistance you need, and pick from five grades: Capcote PE 100, 150, 200, 300 or 400.

St. Regis bag salesmen make sure you get the right sheet for the job. Capcote PE brings you greater flex life, improved adhesion and superior protection—all at lower cost.

Ask your Bag Division representative for full details. Count on him to give you the *best* buy for the *most* protection. And count on St. Regis Packaging-In-Depth for continuing research in packaging materials, equipment and methods to keep your operating costs down!

Write today for literature on Capcote PE-Dept. CE-5, St. Regis Paper Company, 150 East 42nd Street, New York 17, N. Y.

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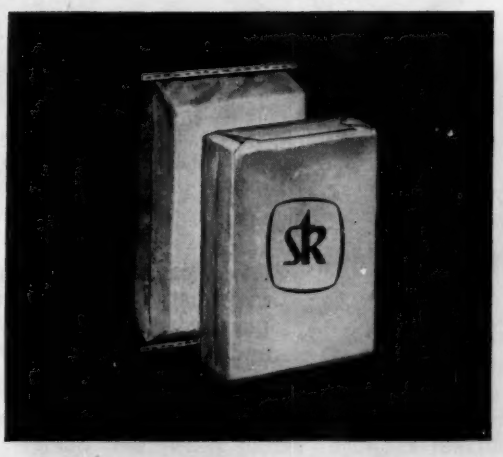

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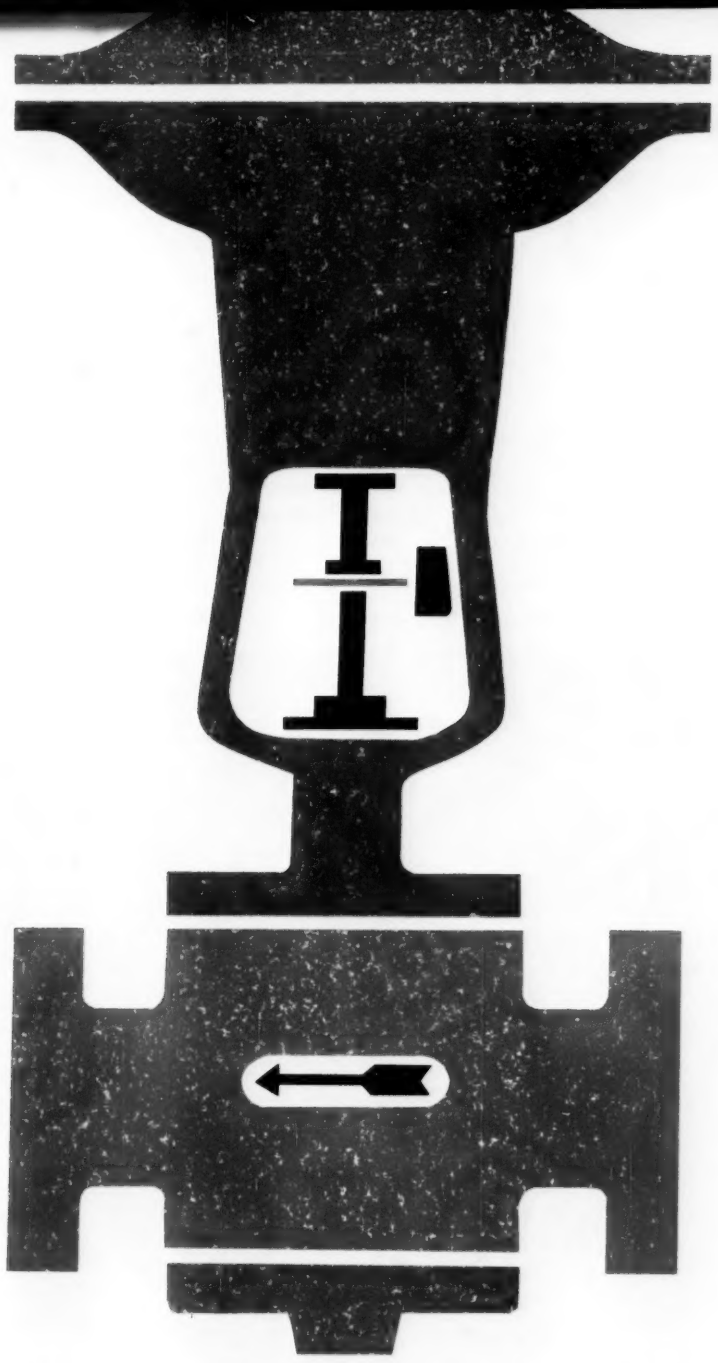


when you're considering control valves, it pays to look at the whole picture!

How do you buy control valves? On price? On the basis of quality of materials and craftsmanship? On flow capacity, sensitivity or other performance characteristics? Sure, these are all important considerations. But no one of them *alone* offers a sound basis for evaluating control valves. You should take into account all of these factors, and many more . . . the whole picture.

A control valve is more than just hardware. It's actually the payoff point of your process. That's why it pays to consider other Honeywell factors, beyond the valve itself—things like process control experience, application engineering, and installation and maintenance supervision. The "whole picture" approach rewards you with best possible valve performance and better processing, regardless of your application.

IF YOU'RE CONSIDERING CONTROL VALVES, STUDY THE HONEYWELL PICTURE FROM EVERY ANGLE . . . YOU'LL FIND IT A BRIGHT ONE.

here's how Honeywell brightens the

Honeywell puts 75 years of control experience to work for you

Honeywell control valve know-how is the first big step in solving flow problems related to hard-to-handle fluids . . . corrosion . . . high and low temperatures. It's experience that started 75 years ago with the application of simple controls to simple processes. Today, this background helps put control valves to work in nuclear energy, missiles, industrial processing, utilities, and other areas.

Honeywell field engineers think in terms of the "whole picture"

Honeywell field men are more than just valve specialists. They're control engineers. Because they work with valves in their relation to the *overall* control system, they can help you get the very best from your entire system.

These eight control valves are representative of the broad Honeywell line.

Versatile, inexpensive . . . for general plant or process flows.

Self-contained, electric motor actuated . . . for plant service applications.

Tight-closing, Saunders type . . . for slurries or other hard-to-handle flows.

Small inner port area assures precise control of small flows in laboratory and process.

FREE VALVE DATA. The ... in our 84-page catalog ... including data on ... other useful information ...

control valve picture for you!

Honeywell application engineers find the answers

The application engineers who back up our field men are experienced in tackling the toughest control problems. They study your flow conditions, performance requirements and potential trouble spots—and find the right answers in terms of correct control valve application.

Honeywell builds extra quality into control valves

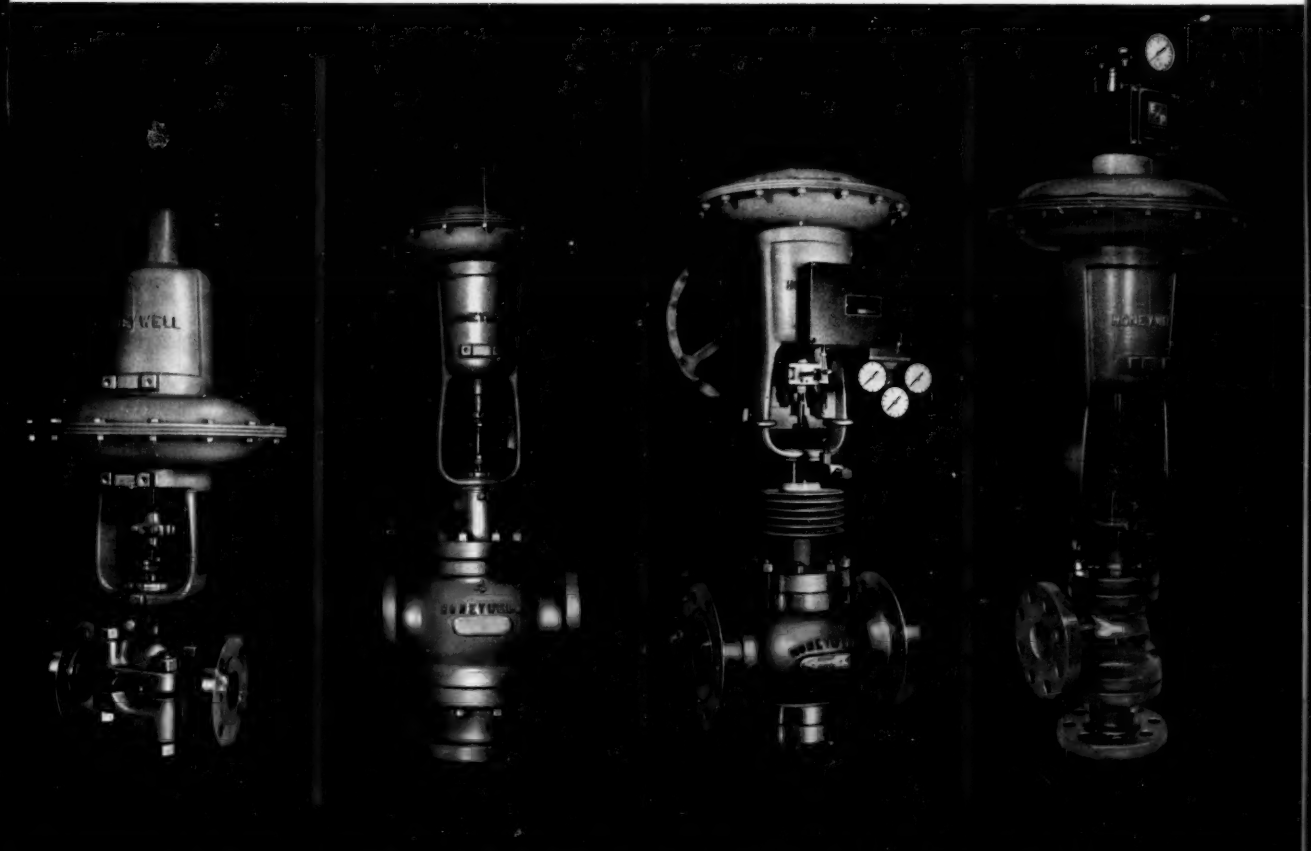
Each Honeywell control valve is the product of first-rate materials, precision machining, careful assembly, and the most rigid testing and inspection imaginable. You can rely on them for long, low-maintenance service—and, for all their ruggedness, they're built to operate with the precision of a fine instrument.

Honeywell delivers on time

You'll like the completeness and "on-time" aspects of Honeywell service. Each order is double-checked against your final process requirements before it's shipped. Stocks of the most commonly used valves and parts are always kept on hand, ready to meet your deadlines.

Honeywell helps install and maintain your control valves

Your local Honeywell service engineer can lend you an experienced hand in installation and startup of your system. Honeywell control valves rarely require any more maintenance than an occasional check of the packing box. But should any trouble arise, a call to your Honeywell branch will bring help on the run.



Split-body simplifies maintenance in control of "problem" fluids.

Balanced, three-way operation . . . ideally suited to mixing or diverting.

Special features and accessories . . . for high temperatures and pressures.

Angle-body, electro-pneumatic positioning . . . exemplifies flow and control versatility.

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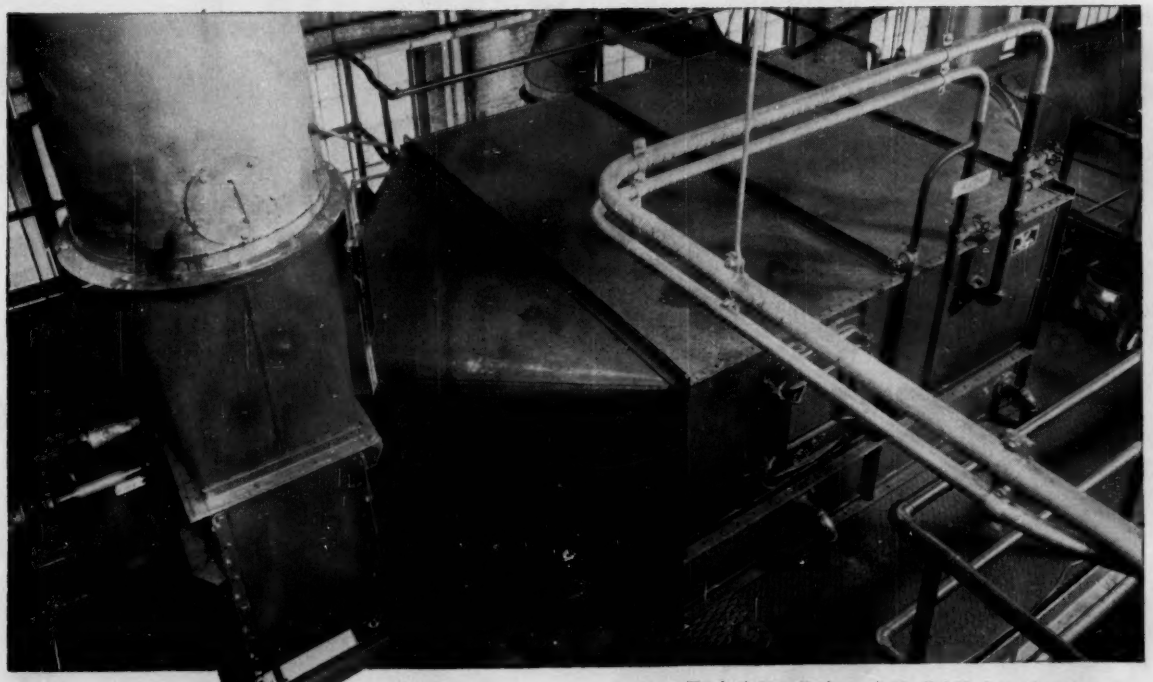
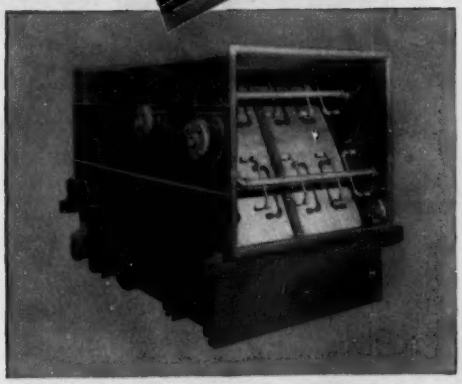
Honeywell

First in Control

SINCE 1885



Typical Installation of "Buffalo" Gas Absorber.



PVC lined gas absorber for handling aqua-regia fumes.

LICK THOSE DIFFICULT ACID MIST EFFLUENT PROBLEMS with "BUFFALO" GAS ABSORBERS

- **Highly efficient**
- **Low air flow resistance**
- **Minimum maintenance**
- **Easy installation**
- **Low operating cost**
- **Compact and lightweight**

"Buffalo" Gas Absorber washers are extremely efficient air pollution control units capable of collecting acid mists and inert particulate material. Utilizing beds of wetted fibers they are finding wide use in treating effluents from such difficult applications as laboratory hoods and open surface tank operations.

Construction of the unit makes it suitable for a wide range of applications. Specific characteristics of the process gas to be treated and the degree of cleaning required will determine the type and number of cleaning stages in the "Buffalo" Gas Absorber. Three distinct gas cleaning components which may be found are: 1. wetted impingement-type cells for removal of particulate materials which would plug fibers if permitted to pass. 2. wetted fiber cells for absorption of gases. 3. dry fiber cells for elimination of fine droplet carry-over from the unit.

The many features of cost, effectiveness and versatility of the "Buffalo" Gas Absorber make it a wise choice for your air pollution control problem.

Investigate the many advantages of "Buffalo" Scrubber Washers *today!* Write for Bulletin AP-125.

"Buffalo" Can Solve YOUR Air Cleaning Problems!

We manufacture a wide line of air cleaning equipment to control many types of air pollution. Your nearby "Buffalo" engineering representative will be glad to analyze your problems and make recommendations. Call him now, or write us for full information.

BUFFALO FORGE COMPANY

Buffalo, N. Y.

Buffalo Pumps Division, Buffalo, N. Y. • Canadian Blower & Forge Co., Ltd. Kitchener, Ont.

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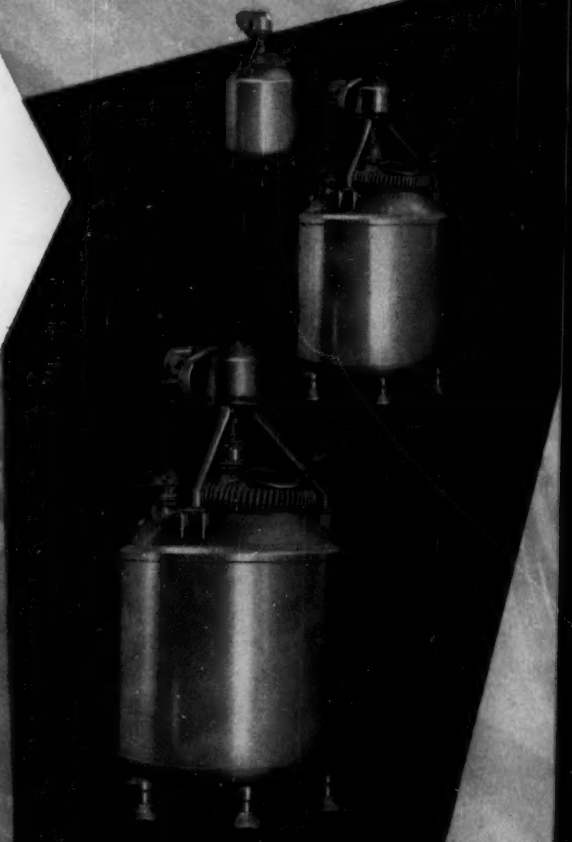
what in blue blazes

Glascote is fanning a creative flame into bigger and better

PIÉCE DE RÉSISTANCE! Just a few months old, 778 is the most corrosion-resistant glass ever applied to chemical processing equipment. More acid-resistant at up to 75° F higher operating temperatures. It's more corrosion and thermal shock resistant than chemical laboratory glass. All this without sacrificing any other protective property.



WE'VE RAISED THE ROOF to give you bigger vessels. Glascote has installed heavier cranes in its new plant addition and raised the arch on its biggest furnace to accommodate reactors to 9000 gallons at pressures to 100 pounds internal and 50 pounds in the jacket. These expanded facilities will also allow a more complete line of equipment to meet growing industry needs.

PROGRESSIVE REACTORS. As new as outer space travel. Glascote's spherical reactor bridges the pressure barrier. It makes possible internal operating pressures up to 330 psi ... jacket pressures to 250 psi. From Glascote—tomorrow's design today.

are we up to ?

glass-lined equipment for the chemical processing industry

AGITATORS IN ALL SHAPES AND SIZES—Glascote's engineering experience in building agitative systems to customer requirements is at your service. Split-hub agitators for noncorrosive service, loose-blade agitators for inserting large blades through small openings, or special designs to accomplish unusual requirements are part of Glascote's customer engineering.

Up to no good for corrosion and contamination — that's for sure! Here at Glascote, glass is fused to steel with a creative flame — a flame that requires the constant spark of new ideas to build stronger defenses against corrosion and contamination. That's why research is another name for Glascote . . . why talent is one of our most important products.

You're probably familiar with some of our "old flames!" In the past, only the best of more than 3000 glass formulas developed by Glascote and its parent organization, A. O. Smith Corporation, gave you superiority in glass-lined reactors, columns, storage tanks, rotary dryer-blenders, pipe and fittings.

But remember, we said that our flame feeds on new ideas. Pictured at the left are some of our latest and brightest contributions. In keeping with this philosophy, others are on the way.

For additional information ask your Glascote representative for specific product data. Or, if you prefer, write direct: Glascote Products, Inc., Cleveland 17, Ohio.

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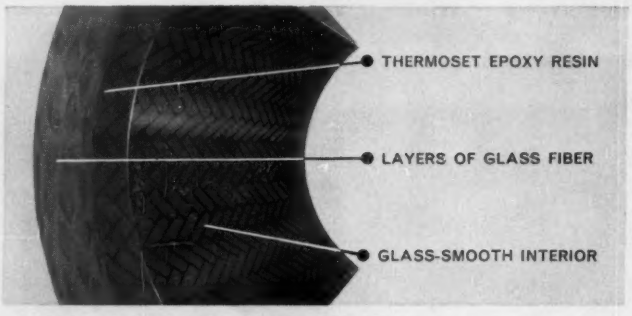
World's largest manufacturer of glass-protected steel products



EPOXY RESIN AND GLASS FIBERS combined in a high-speed centrifugal casting operation. High quality components processed under rigid quality controls bring to industry a unique and efficient non-metallic pipe.

"Impossible" corrosion, temperature and pressure problems solved by Fibercast® epoxy pipe

- Operating temperature range wider than any non-metallic pipe (–65° to 300° F.)
- Operating pressure range extends to 1000 psi.
- Effectively combats corrosion, contamination, abrasion, scaling, electrolytic action.

Fibercast Tubing (right) used to suspend a 1,200 lb. pump for 3 years in a salt water supply well. *There was no loss in strength.* The damaged plastic-coated steel nipple (left) was used in the same installation, failed after 3 months' service.

WHAT is Fibercast?

It is a centrifugally cast, thermoset, epoxy resin reinforced pipe that handles temperature and pressure problems where no other non-metallic pipe will do.

Its body of woven glass fibers provides resistance to high tension forces. These fibers, combined by adhesion, are imbedded and bonded by heat in epoxy resin. The result is a strong, long-lasting pipe with remarkable ability to withstand high pressure and temperature in corrosive environments.

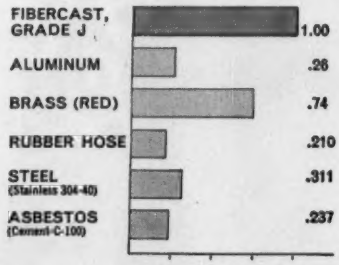
WHY use Fibercast?

For a multitude of reasons. Because its advantages range from superior resistance to heat, pressure and corrosion, to its ease of handling, light weight, dielectric properties and structural stability. Because Fibercast's long service life alone would justify choosing it over other materials. Because even more expensive metal pipe or pipe with thermo-plastic interior coatings cannot match Fibercast's proven durability. Case histories and accurate testing have proved over and over that Fibercast performs better, lasts longer, costs less. Out of 338 common corrosive solutions, Fibercast competently handles 320. And naturally, Fibercast's unique and lasting qualities under such conditions mean that it drastically reduces maintenance and replacement costs, too.

Although Fibercast's light weight makes it correspondingly easy to work with (it is less than 25% the weight of steel), it has the same basic linear coefficient of expansion as steel (7.06 x 10^{-6} to 8.25 x 10^{-6} in./in./°F.). Fibercast's strength permits installation on pipe racks with span lengths generally used for metal pipe.

The pipe has a smooth interior, with a Hazen-Williams C Flow Factor of 147. This cuts friction losses, aids flow and tends to resist build-up. It is a non-conductor (accepted by the electrical industry as a superior insulator), and is not subject to cold flow. A low coefficient of heat transfer (3.0 x 10-3 Cal/CM^2/sec/CM°C.),

COMPARATIVE LIFE DATA*



**Basing Fibercast as unit life of 1 and others as comparative percentages thereof.*

minimizes heat loss and may even eliminate heat tracing.

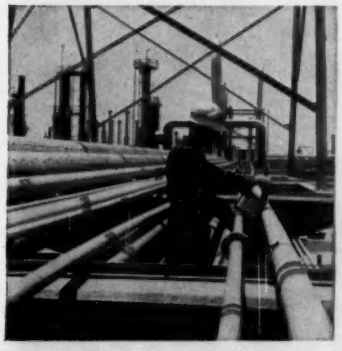
All three major systems of joining all pipe are used with equal success on Fibercast. They are: standard flanged, cemented, and threaded and coupled with a complete selection of Fibercast fittings (the world's largest line of corrosion-resistant epoxy pipe fittings).

Safety, too, is an important reason for using Fibercast Pipe in transporting dangerous chemicals, particularly in areas where the pipe is adjacent to personnel. Most piping materials corrode undetectably from inside-to-out and can suddenly burst without warning, inflicting injury to personnel. Because of Fibercast's woven glass fiber construction, such occurrences, if they ever occur, *are* detectable in minute, repairable leaks.

WHO uses Fibercast?

The petroleum industry . . . chemical . . . petro-chemical . . . nuclear energy . . . textile . . . paper . . . and food-processing industries . . . countless operations handling acids, alkalies, salt water and other corrosive liquids under pressure can all use Fibercast profitably.

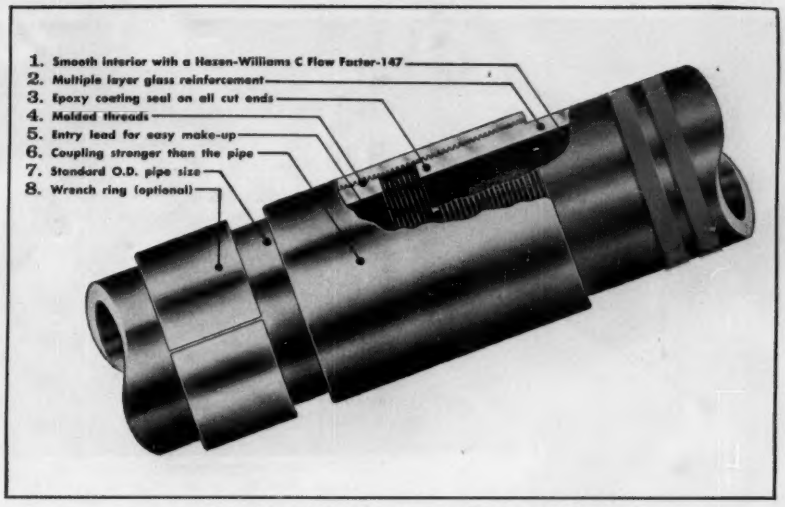
In oil country, Fibercast is already



Workman is painting a section of Fibercast Pipe bearing 32% HCl at Shell's Texas Chemical plant. Note that Fibercast has sufficient strength for installation on span racks with the spacing normally used for metal pipes.

widely acclaimed for superior performance in rugged, abusive and even high pressure installations like salt water disposal wells and horizontal lines. In cases where other pipe and tubing required replacement after just a few weeks of service, Fibercast is still performing efficiently after many years.

In petro-chemical and chemical-processing plants, Fibercast is valued not only for high heat and corrosion resistance, but also for its remarkable maintenance of the purity of the solutions it is required to carry. Such installations range from Fibercast pipes which carry 37% hydrochloric acid at ambient temperatures to lines carrying solutions containing brine, alum, and other sulphates, sulphuric and phosphoric acids, and other damaging chemicals.


1. Smooth interior with a Hazen-Williams C Flow Factor-147
2. Multiple layer glass reinforcement
3. Epoxy coating seal on all cut ends
4. Molded threads
5. Entry lead for easy make-up
6. Coupling stronger than the pipe
7. Standard O.D. pipe size
8. Wrench ring (optional)

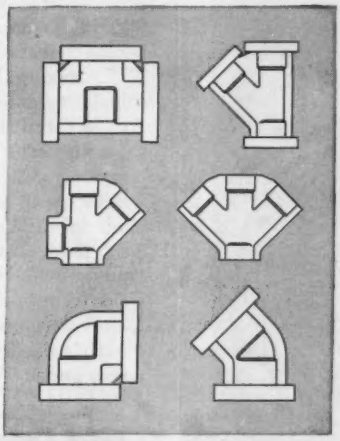
8 Points of Fibercast Superiority

Food-processing industries, among the most demanding of all industries in purity, corrosion and heat standards of operation, know the long-term benefits of using Fibercast. Fibercast is especially effective in the processing of foods requiring use of sulphuric and phosphoric acids (such as corn syrup, starches, gelatins), as well as brines and other highly corrosive acids and solutions.

The operating conditions peculiar to the man-made textile and paper processing plants are also improved by the use of Fibercast Pipe and Fittings. The ever-growing demands of all industry . . . the rigid quality controls imposed by governmental and other agencies . . . the unique and often unsolved needs of new processes and methods . . . all of these factors help to create "impossible" problems that can be solved by the use of Fibercast.

Complete Line of Fittings

Fibercast provides fittings to solve any fitting problem. Besides a vast stock of standard sizes and types, Fibercast also designs and makes special fittings to meet individual requirements. All, of course, have the same corrosion, pressure and heat resistance properties of Fibercast Pipe and Tubing. A few of the regularly stocked types are shown in the line drawings below.



If *you* have an "impossible" corrosion, temperature, or pressure problem, consider the advantages of using Fibercast. To receive a free sample of Fibercast, and to get specific information about how Fibercast can help *you*, mail the coupon below.

FIBERCAST COMPANY
BOX 727, Sand Springs, Oklahoma

Please send me further information about Fibercast Tube and Pipe. CE-5A

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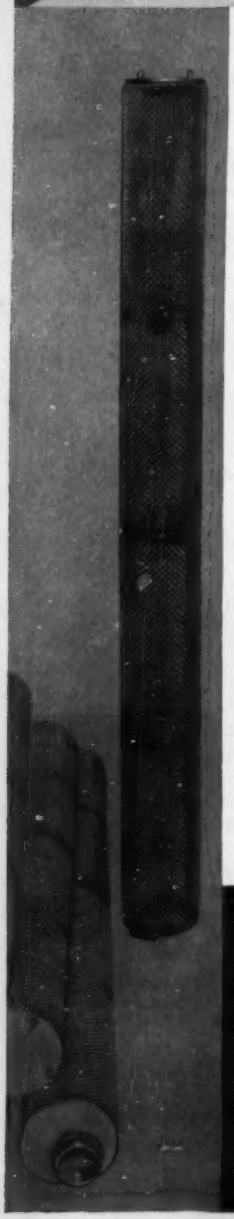

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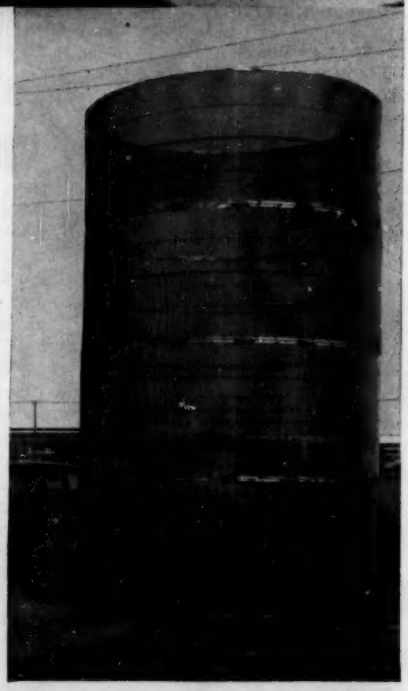


HOKE Flow Sheet 2

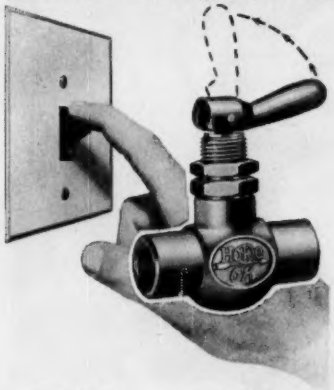
HOKE REPORTS ON FLUID CONTROL

WE'VE PACKED PERFORMANCE IN A PACKLESS VALVE

How to be "Flip" About On-Off Control

We've turned the tables on electrical engineering profs who try to demonstrate current flow by describing a valve on a pipe. Our switch-action toggle valves stop and start flow just as easy as: Flip, it's on! — Flip, it's off!

These valves perform a basically simple function, but a lot of engineering went into them to insure perfect performance. Many are used on precision test equipment and for control applications, often in conjunction with automatic controls as a manual safeguard for fast shut-off. Designed for both



gas and liquid service, the stem seals are tight enough for most vacuum work, too. We certainly can't be flip about these specifications.

Hoke manufactures two types of toggle valves. The 450 Series has maximum operating pressures up to 200 psi. These are spring closing valves made in ¼" and ⅛" pipe sizes which can be classified as "miniatures", measuring less than 2" in height in the closed position. They are normally supplied with moulded, black, Nylon handles, but colored handles can be supplied for special identification purposes. Panel mounting lock-nuts are included as standard equipment on every valve.

The second type is the 490 Series, a cam-closing toggle valve for service up to 2000 psi. They'll give you the same quick, positive action as the 450 Series, while performing the toughest laboratory and process jobs. The 490 and the 450 are excellent performers on non-critical high vacuum. They can be helium leak-tested for this purpose.

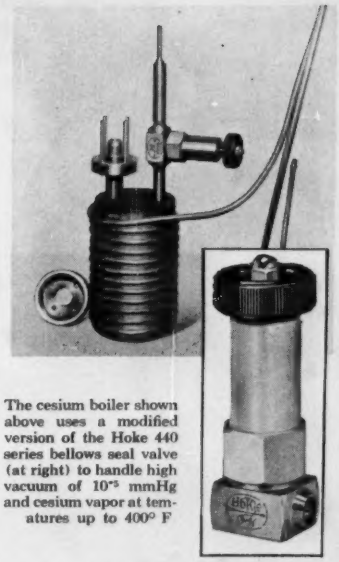
So, if you're interested in switch-action flow control, investigate the Hoke toggle valves. We'll be happy to equip you with complete technical data. A check in the coupon to the right will bring you the facts.

The development of packless valves has so greatly reduced the problems of handling high pressures, temperatures and vacuums, and dangerous fluids that engineers designing such systems can now spend more time curled up with the Hoke Corrosion Chart.*

With this extra time, many have dreamed up weird applications for the Hoke 440 Series bellows seal valve, trying to snare us in our own semantics. In a rash moment, we boasted that this valve could be modified for almost any application. Actually, the 440 can be modified to work at high pressures (up to 2000 psi), for high temperatures (up to 1000°F.), and for special connections such as tubing, socket welding, and silver brazing.

Aside from this horn-blowing, here are the dry facts. The basic design includes a stainless steel body, inert arc-welded bellows assembly, Teflon gaskets and Teflon stem point discs. This is only the starting point. Minor modifications make so many models available that almost any problem, including liquid metal handling, can be solved.

Hear what a disbeliever said: "I did not believe that the modified valves would satisfy all my requirements, especially to keep a high vacuum of the order of 10^{-8} mmHg under a wide variation of temperatures; however, I now acknowledge that the modified Hoke 440 valves fulfilled their duty perfectly." This came from The Martin Company, where we sent 440's for use in cesium vapor up to 400°F. Special



The cesium boiler shown above uses a modified version of the Hoke 440 series bellows seal valve (at right) to handle high vacuum of 10^{-8} mmHg and cesium vapor at tematures up to 400° F

modifications made these valves readily usable on a cesium boiler and converted an infidel to the true valve.

If you work with critical high vacuum, high pressures, high temperatures and dangerous fluids, proceed with care. Ask for our Packless Valve Bulletin to reap a harvest of engineering plums.

** Makes good reading if you're handling corrosive agents. Write, and we'll send you one.*

FREE! A STEADY FLOW OF FACTS!

Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

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Corrosion can't hide in this fluid end!

You can easily detect corrosive action *before* breakdown with this Goulds Fig. 3715 centrifugal chemical pump.

Turn a few bolts and off comes the casing cover. Then you can inspect the impeller and clean out the insides *without disturbing pipe connections.* A millwright can do the entire job alone.

Mechanical seal or stuffing box is subjected to suction pressure only, reducing the sealing problem to a minimum.

The 3715 handles a wide range of corrosive liquids. It is available from stock in Type CF-8M (316) stainless, Gould-alloy 20, all-iron, aluminum bronze, bronze-fitted or iron with stainless trim. Ten sizes. Temperatures to 350 F. Capacities to 720 GPM, heads to 280 feet.

Write for Bulletin 725.4: Goulds Pumps, Inc., Dept. PT-99, Seneca Falls, N. Y.

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These are reassuring facts to count on, whatever your product where tubing is used. They mean easier fabrication at lower cost, together with complete dependability in performance on the job.

Great design freedom is provided by the wide range of carbon and stainless grades at your command in welded steel tubing. Write for data-filled Bulletin 8591—and for immediate information on your current requirements, call a quality welded tube producer.

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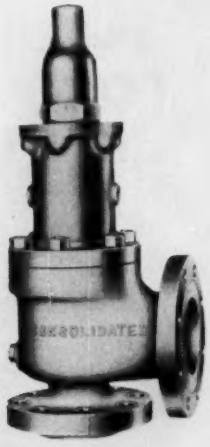
top

CONSOLIDATED SAFETY RELIEF VALVES have a special "O" Ring Seat Seal that stops leakage completely



Consolidated Safety Relief Valves are available in both Standard and Balanced Bellows design for extreme corrosive applications.

tightness

The Seal is a resilient ring set in the valve disc. It maintains no-leak tightness by contact with a specially curved seating surface on the valve nozzle, yet does not carry the seat load imposed by the valve spring.

Tightness is maintained at operating pressures far closer to set pressure than with metal-to-metal seats alone. Tight closure is as efficient after "simmer" as on normal blowdown. Piping strains are absorbed far better by the resilient seal than all-metal seating. If the tough seal is ruined by entrained abrasives, replacement is easy. Seals are available in materials that resist corrosive fluids. Maintenance costs are greatly reduced.

Standard Consolidated Safety Relief Valves have an eductor tube that removes pressure from the closed bonnet. Only the spring controls valve action. You get guaranteed capacity ratings and highest dependability—absolute protection for personnel and equipment. Additionally, there is the economy of converting the Standard valve to the Balanced Bellows type in your own shop. Get complete details. Write for Bulletin 1940.

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Proctor® solves every drying problem...almost

This one puzzles us for the moment—largely because we're so busy solving individual drying problems in chemical processing. In fact, Proctor has been doing just that for over 75 years.

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1 HOM, a new alloy developed by Duraloy metallurgists and capable of retaining high working strength at temperatures up to 2200°F, with limited application at 2300°F. The alloy is applicable for all types of castings: static, centrifugal, shell-molded.

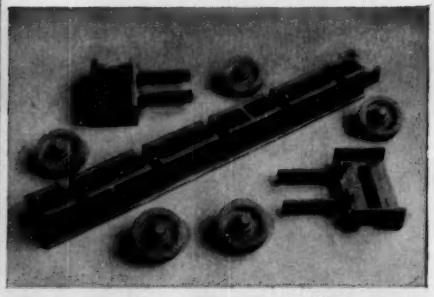
2 Shell-molded castings for meeting close and rigid tolerance limits; post-casting machining or other finishing practically eliminated; low mass production costs.

Illustrating 4 of Duraloy's Major Casting Services

If the casting used in your equipment has to meet high temperature (anything up to 2300°F) and/or corrosion, why not discuss your requirements with our metallurgical staff? Our company can call upon more than 35 years of experience in this exacting business of high alloy castings. In the meanwhile, if you would like to have a copy of our latest catalog, write or call our nearest office.

3 Centrifugal castings which produce a denser, more uniform metal approaching forged metal strength.

4 Static castings which can be produced in weights ranging from a few ounces to single castings 7 tons and heavier; wide range of alloying combinations, including the new HOM referred to above.



Note

As a point of interest, all of the castings shown here were produced for Lindberg Engineering Company, Chicago, for incorporation in heat-treating and annealing equipment sold by that company. The centrifugally cast tube for the generator, trays, and rollers for the furnace rails are cast of HOM. The rails and rail supports for the furnace are statically cast of 35-15 alloy.

ALLOY CASTING INSTITUTE ACI MEMBER

DURALOY Company

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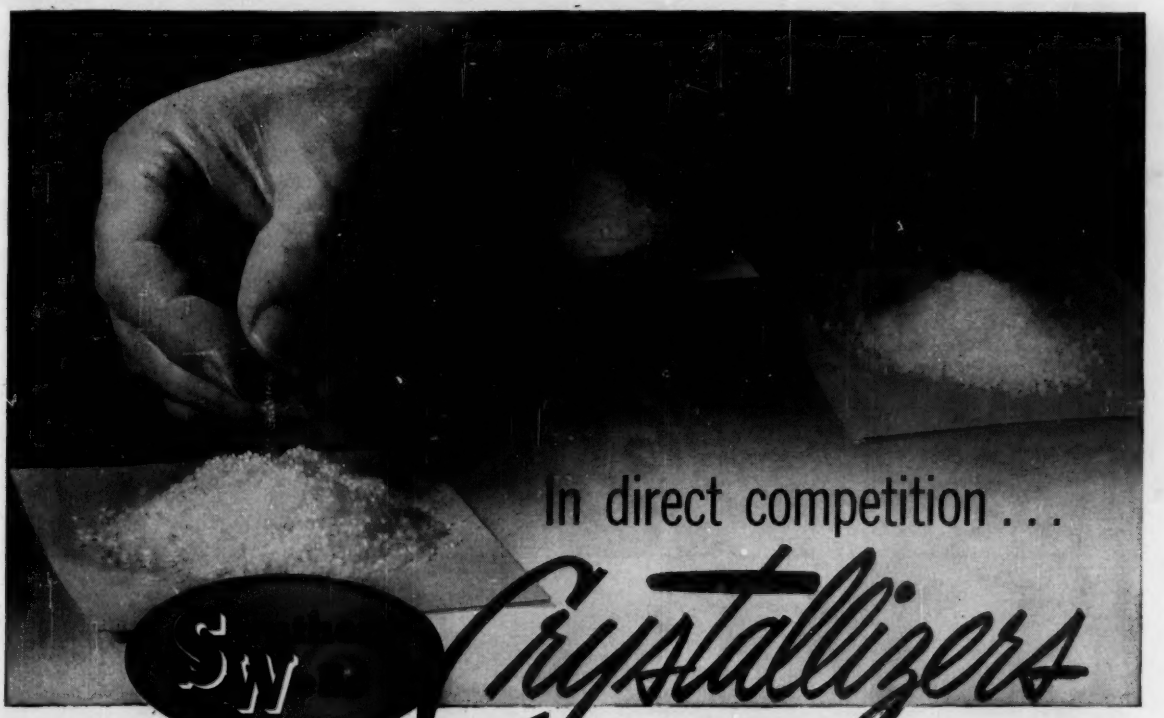

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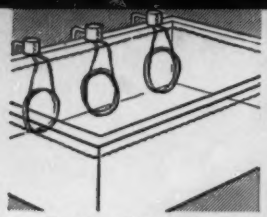
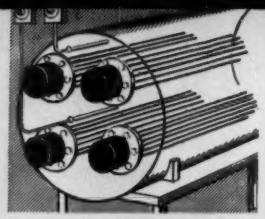
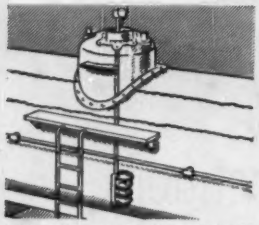


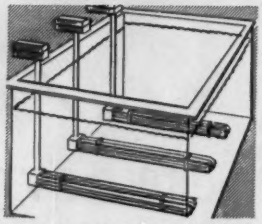
For plating applications, Chromalox CT Immersion Heaters are sheathed in lead, copper, stainless steel.



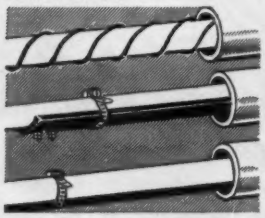
Water heating with TM flange-type Immersion Heaters mounted at one end of a tank.



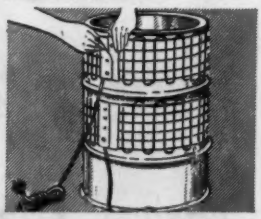
Heating viscous materials with BLCK Immersion Heaters before pumping from a railroad tank car.



Heating liquid held at constant level. TL Heaters generate heat parallel to the tank bottom.



Pipe heating with Chromalox Thermwire (300°F), Strip Heater (750°F) and Tubular Heater (1100°F).



Heat for 5- and 55-gallon drums. Just snap on and plug in. Protective coating resists abrasion, chemicals.

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Regardless of what your heating problems may be . . . your best chance of finding the best answer is to call your Chromalox Man.

- He represents more than 15,000 different types, sizes and ratings of electric heaters and heating elements . . . the world's largest line.
- He orders from the world's largest stock.
- And he is a *heating expert* . . . he understands your problem and can help you find the answer.

No matter what your heating problem is . . . solids, liquids or gases . . . call your Chromalox Man for the efficient, *electrical* answer. (*His phone number is listed at the right.*) Or, check the boxes below, write your name, title, and address at the bottom of this page and mail the coupon to us. Edwin L. Wiegand Company, 7500 Thomas Boulevard, Pittsburgh 8, Pa.

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☐ Send me specific information on the heating problems I have outlined on the sheet attached.
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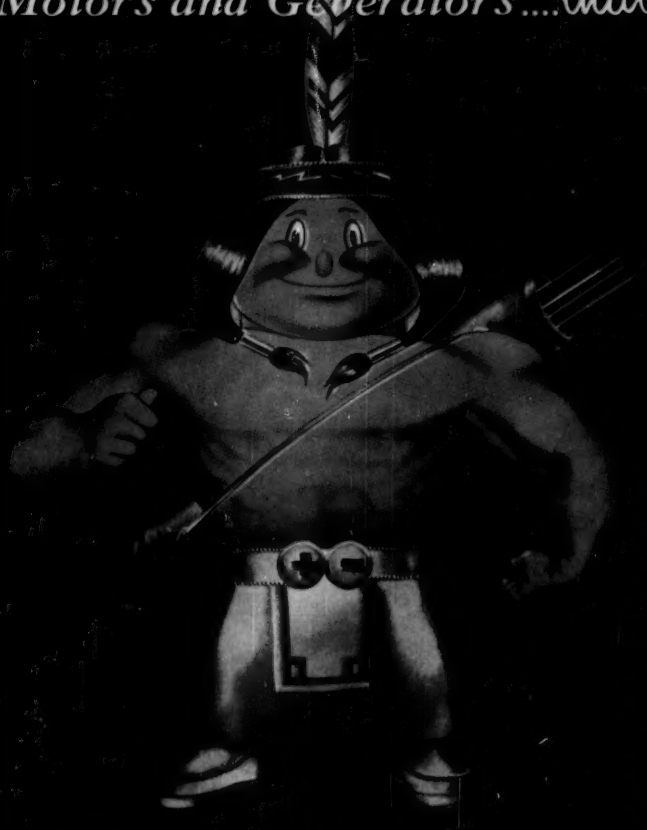

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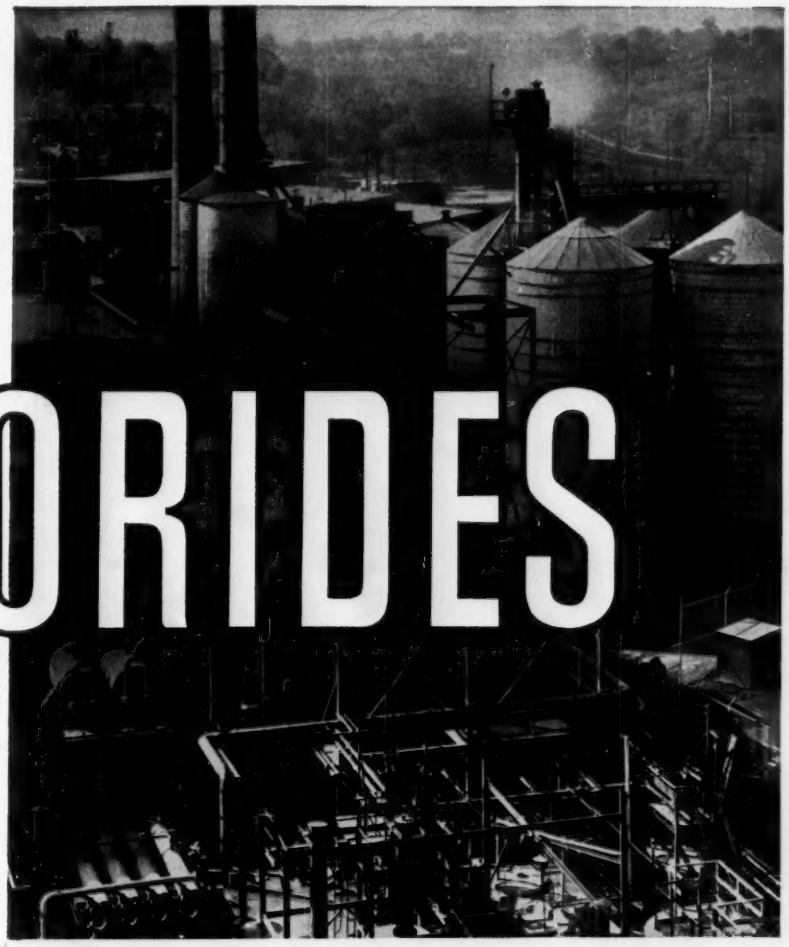

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ANOTHER FIRST FOR HARSHAW

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In 1904 when The Harshaw Chemical Co. first started to manufacture hydrofluoric acid, all of the production was used by foundries to remove sand from iron castings. Today, Harshaw's fluoride division produces 26 different fluoride chemicals for as many industries.

The major uses of Harshaw Fluorides are in the petroleum, glass, steel, and atomic energy industries. Even in these industries the uses are diversified. The versatility of Harshaw fluorides is also evident by their use in soldering fluxes, cleaning boilers, removing iron stains and souring laundry, curing plastics, alloying aluminum, floating minerals, sanitizing breweries, and treating water.

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Partlow controls are actuated by the direct, positive power of mercury, require no mechanical or electronic amplification. Regardless of type, any Partlow you install will stand up to even extreme conditions of shock and vibration . . . without loss of accuracy or sensitivity.

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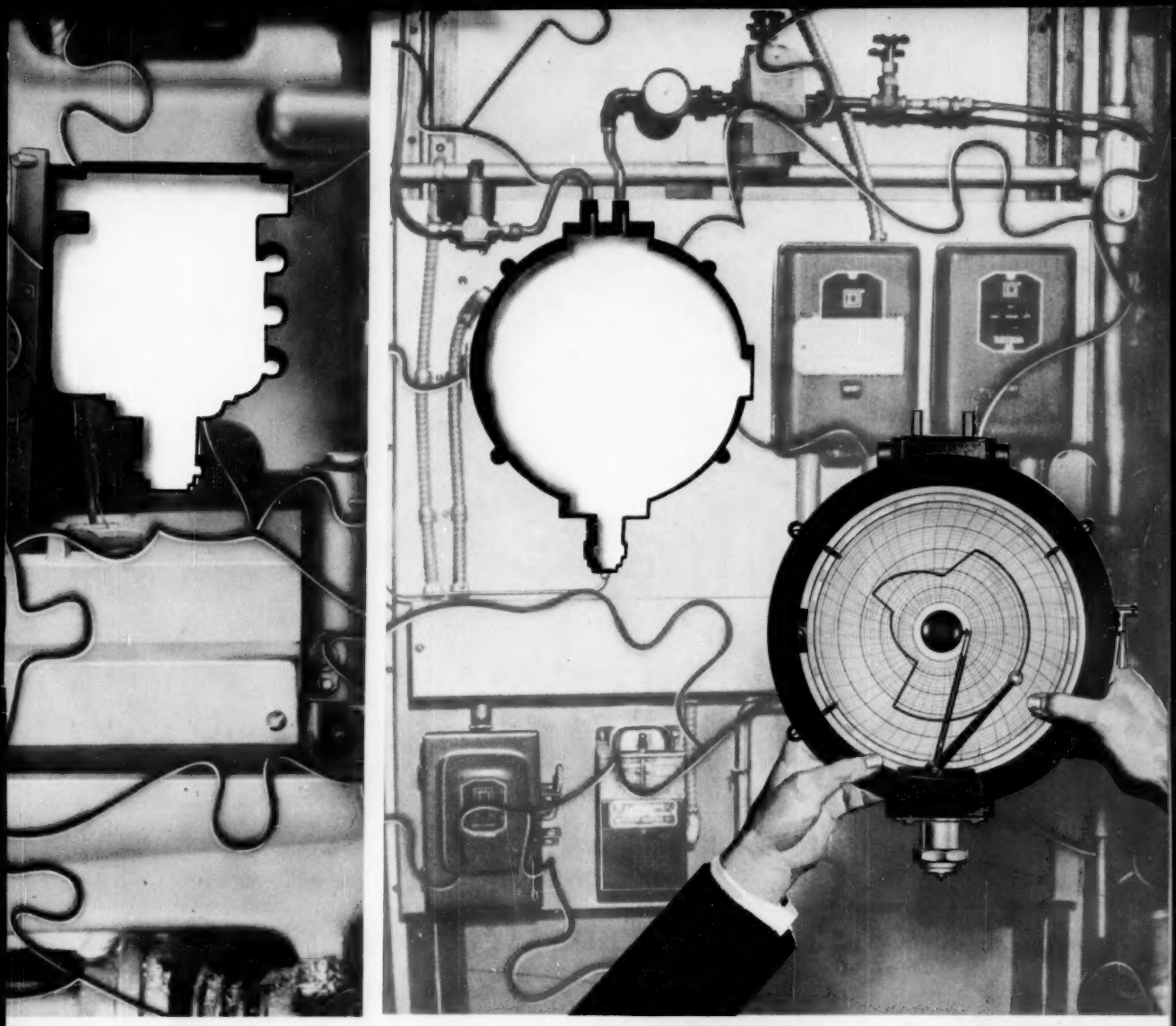

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In acid bath below flange at center, Ni-o-nel alloy heater remains sound — including weld at submerged elbow seam. Plant now specifies Ni-o-nel alloy for all such heaters.

At Pittsburgh Steel Company:

NI-O-NEL alloy solves 15 year problem ...hot sulfuric acid mixtures

The heater this man is looking at warms a violently corrosive bath: 5% sulfuric — 5% nitric acid. Three submerged steam heaters keep the mixture at 150°F. For 15 years, engineers of Pittsburgh Steel Co.'s Thomas Strip Division have tried to build extra life into these heaters. They tried metal after metal, but most lasted only months, causing frequent and costly shutdowns.

But the one heater shown — in service since September, 1958 — was recently pronounced still good as new. It's made of Ni-o-nel* nickel-iron-chromium alloy . . . for corrosive conditions of unusual severity. According to L. J. Crincic, chief engineer at Thomas Strip, "The Ni-o-nel alloy heaters are as good as when they were put in the acid tanks. On the basis of our experience, we plan to go to Ni-o-nel alloy for all heaters on all six lines."

Resists acids, oxidizers . . . "problem" waters, too

Ni-o-nel alloy provides excellent resistance to sulfuric acid in concentrations up to 40% by weight at boiling temperature . . . up to 60% at 80°C. In H_2SO_4 at 280°F., Ni-o-nel alloy parts are outlasting others by 3 to 5 times.

Oxidizing salts other than chlorides usually improve its performance in sulfuric acid. That's why Ni-o-nel alloy has unique staying power in mixtures containing nitric acid, cupric or ferric sulfate.

Ni-o-nel alloy resists most organic acids...gives excellent protection against boiling acetic acid and acetic-formic mixtures. And its properties make Ni-o-nel alloy a good choice for heat exchanger parts subject to pitting and stress corrosion — by sea water and other chloride-containing waters.

Wide selection of Ni-o-nel alloy forms

Plate . . . pipe . . . extruded tubing . . . seamless condenser tubing: Ni-o-nel alloy is available in all standard mill forms, all easily fabricated. With the proper rods, Ni-o-nel alloy provides welds as strong and corrosion-resistant as the parent metal. Write for Technical Bulletin T-37, "Engineering Properties of Ni-o-nel." And let us know your problems with metals in corrosive conditions. Perhaps we can help you find the best answers. *Inco trademark

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The International Nickel Company, Inc.
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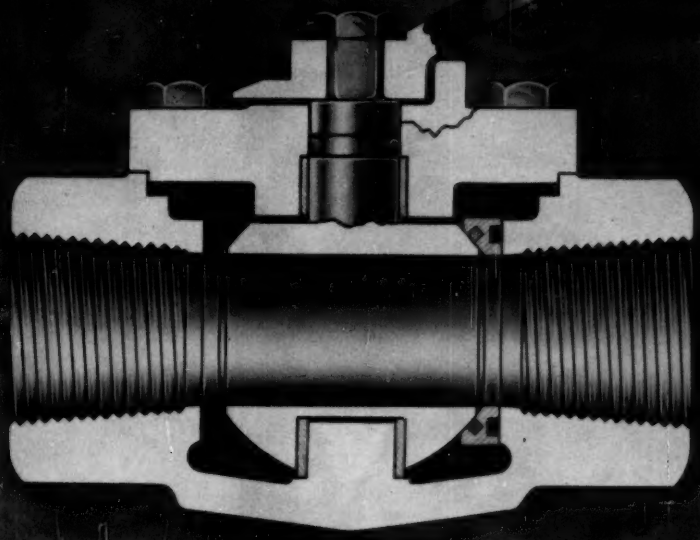
NI-O-NEL®

...how can 1 valve replace 3?



Better **FLOW** *than a* **GATE...**

but, unlike gates, the *FLO•BALL* valve doesn't freeze or jam . . . it never leaks . . . the seats don't score . . . it requires no maintenance . . . and just a ¼ turn opens or closes it.

Better **SEALING** *than a* **GLOBE...**

but, unlike globes, *FLO•BALL* gives zero leakage . . . in both directions *without* seat distortion . . . closes easily without massive operators . . . gives more than twice the flow . . . and the fastest action of any valve made.

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Bearing-fixed ***FLO•BALL*** valves are stocked with flanged or screwed ends, full or reduced port, in standard sizes from ⅛" to 10". They are made to standard ASA dimensions in carbon steel and 316 stainless steel.

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Perhaps your bearing-fixed ***FLO•BALL*** valves can fill my applications. I require valves for_____

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I now use ball valves in these sizes_____.

PLEASE: ☐ Have salesman call ☐ Send technical data

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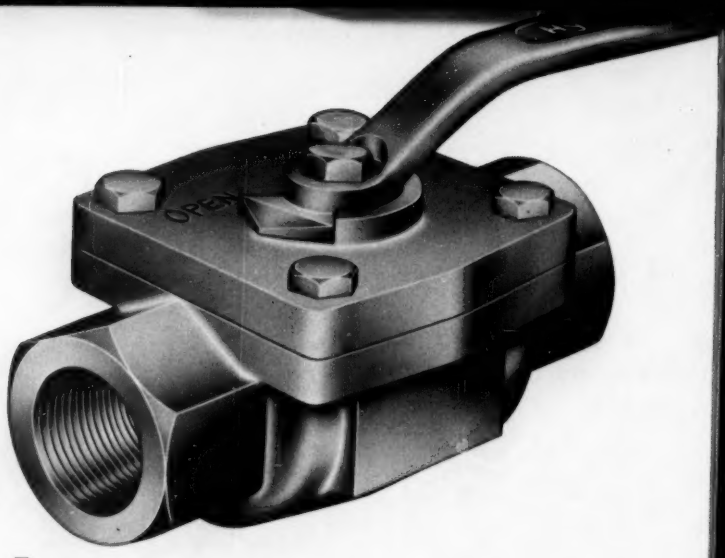

....how the FLO•BALL® reduces your valve costs 3 ways!

1. Reduce initial costs . . . *by using fewer valves per system. FLO•BALL valves are used in place of gates, globes, or plugs.*

2. Reduce inventory costs . . . *by standardizing on one type valve for all applications requiring gates, globes, or plugs.*

3. Reduce maintenance costs . . . *the FLO•BALL high reliability means less maintenance . . . no lubrication, no freezing, positive sealing. The top loading and replaceable seat reduces overhaul and start-up costs.*

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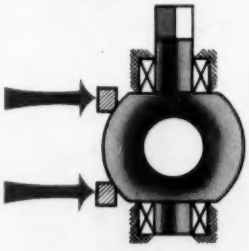
In the bearing-fixed FLO•BALL valve all pressure forces exerted on the ball are transmitted to low-friction bearings. The pressure balanced seat results in a sealing force which is designed to insure positive sealing without seat distortion, and to minimize seat-resisting frictional forces. The combination of these low frictional forces accounts for the extremely low operating torque.

FLO•BALL VALVE
Fixes ball • Floats seat



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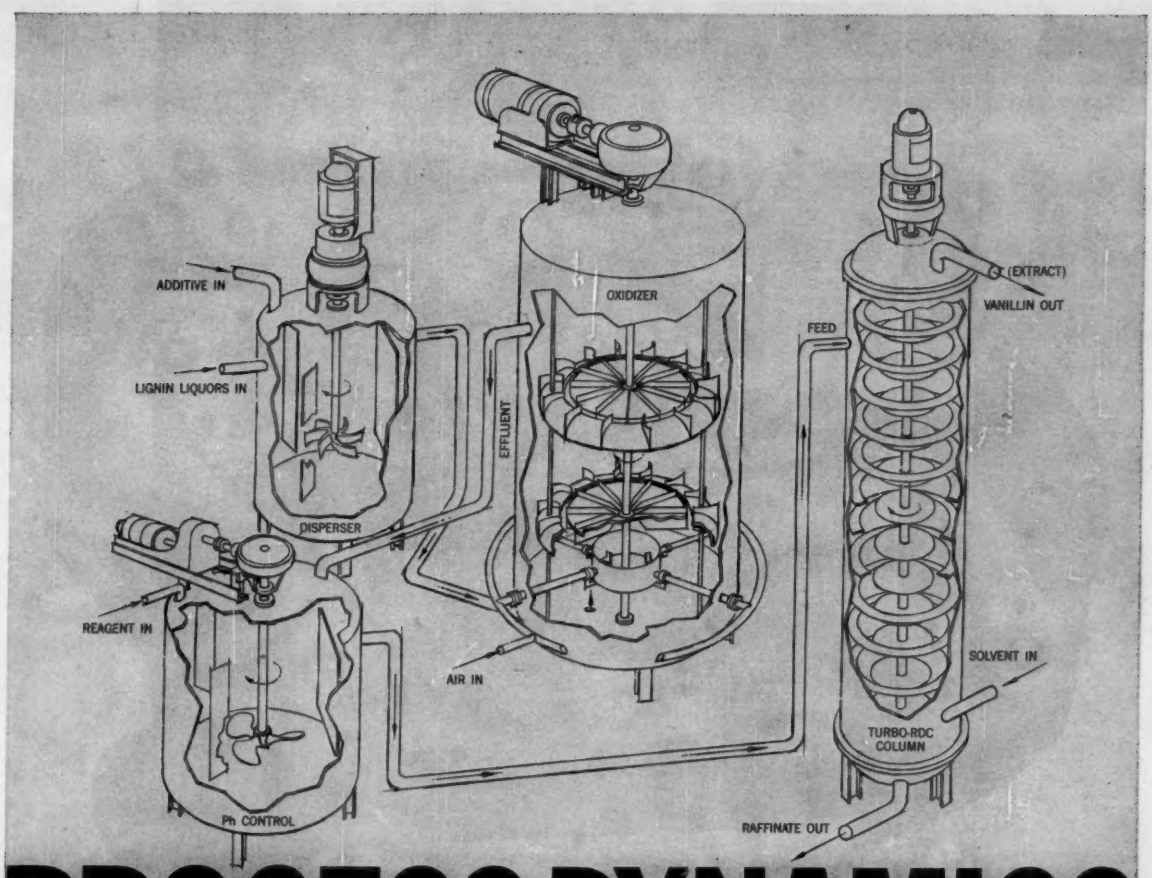

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TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXERS—LOUISVILLE PROCESS EQUIPMENT—TRAYLOR ENGINEERING—FULLER COMPANY—DRACCO DIVISION—SUTORBILT—KANIGEN CHEMICAL PLATING—PLATE & WELDING—WIGGINS CONSERVATION STRUCTURES—FIELD ERECTION DIVISION—blowers • compressors • conservation systems • conveying systems • coolers • crushers • cryogenic equipment • crystallizers • dewatering presses • dryers • dust control equipment • evaporators • extraction equipment • fans • fractionating columns • gas absorbers • gasholders • mixers • preheaters • pressure vessels • pumps (gas and vacuum) • rock product processing equipment • storage tanks (floating, fixed and lifter roofs)

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

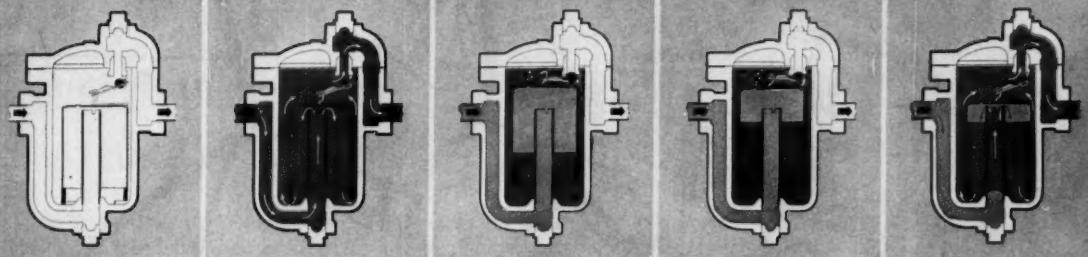
Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
313 WILSON, SO. NORWALK, CONN.

This simple trap operating principle provides the efficiency, dependability and freedom from maintenance necessary for the most profitable use of steam



When trap is first installed, the inverted bucket is down and the valve is wide open.

When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until —

Steam (light color) reaching the trap floats the inverted bucket and closes the valve.

When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

Key: condensate steam steam bubbles air bubbles

ARMSTRONG INVERTED BUCKET STEAM TRAPS

are designed and made to give you these big benefits:

● Amstrong Traps, the first inverted bucket steam traps, now represent the most advanced development of this time-proven principle. They provide all the advantages necessary for efficient, economical condensate drainage from virtually all types of steam using equipment.

1. *No steam loss* – Steam never reaches the orifice even when there is no condensate load.
2. *Automatic air elimination* – Vent in trap bucket passes air and other non-condensibles through to be discharged with condensate.
3. *No cooling leg required* – Condensate is discharged at steam temperature as fast as it reaches the trap because trap operates on difference in density between steam and water not on temperature.
4. *Operates on any back pressure* – Failure of one trap in system will not cause others to open because high back pressure does not affect an Armstrong trap other than to reduce capacity. As long as there is a pressure differential across the orifice the trap will close on steam and open for condensate.
5. *Unaffected by ordinary dirt* — Swirling action of condensate keeps dirt in suspension until discharged with condensate, prevents it from lodging in valve.
6. *Completely dependable* — Proved design plus the use of all stainless steel working parts assure continuity of service and length of service unmatched by any other trap.
7. *Big capacity in a small, economical package* — Armstrong design gives you the highest practical capacity for any given pressure. And remember, Armstrong capacity ratings are based on *hot* condensate at the *working pressure differential* stated, not on theoretical orifice capacities.

Further information on these advantages plus much additional information is given in the 48 page Armstrong Steam Trap Book. Ask your local Armstrong Representative or write direct.

860 Series for low pressure heating service.

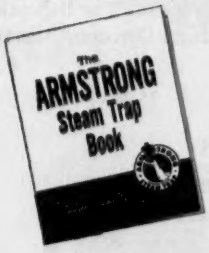
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.



The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

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B&W *Job-Matched seamless pressure tubing*

B&W offers you . . .

- sound engineering assistance on tubing end-use and fabricating requirements
- mutual understanding toward achieving the most satisfactory and economical tube performance
- the extensive facilities of 2 tube mills—plus a nationwide network of district sales offices and steel service centers manned by *experienced* tube salesmen—equipped to serve you with efficiency and dispatch

These are just a few of the many reasons why it pays to specify B&W Carbon or Alloy Seamless Pressure Tubing or Pipe. And remember—matching tubes to jobs assures you the *right tube,* in the *right quantity,* at the *right time.* For more information, call your local B&W District Sales Office, or write for Bulletin TB-417. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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B&W THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

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CRUSHING LIGHT AND ABRASIVE MATERIALS?

Pennsylvania CDL Series Reversible Impactors offer 5 unique advantages

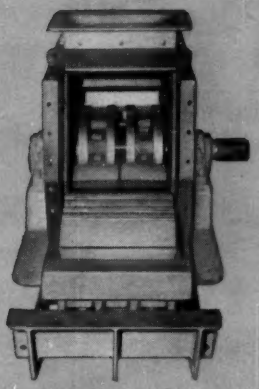
This is the crusher designed specifically for jobs where weight and ruggedness are unnecessary —such as crushing light and often abrasive materials. To plant operators with such job requirements Pennsylvania CDL Series offers:

1. Definite wear advantage accomplished by use of cast alloy steel in all hammers and breaker blocks. Side lines are of heat-treated carbon steel.

2. Adjustable upper and lower breaker blocks. In some series the upper blocks are reversible. Maximum control of circulating load and product gradation is achieved by merely moving upper and lower blocks closer to or further from the hammer circle.

3. Easy accessibility. The entire upper and lower breaker block assembly swings back, exposing the entire rotor assembly, thus holding maintenance time to a minimum.

4. Identical reduction. With breaker blocks located on both sides of the machine, and feed chute directly over center of the rotor, these units perform identical reduction when run in either direction.

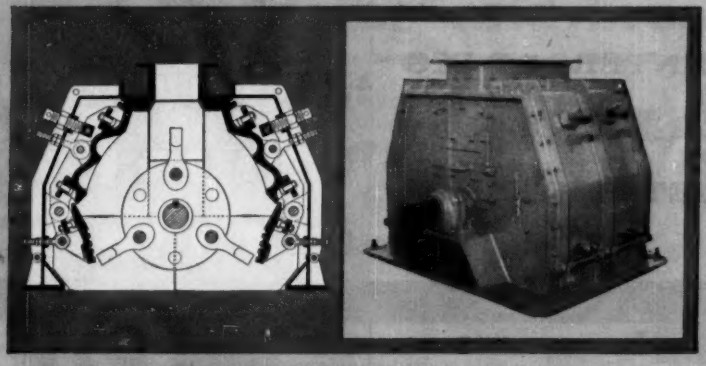


• Pennsylvania CDL 5-32 Reversible Impactor with breaker block assembly open to show easy accessibility.

5. Balanced wear. Systematic rotor reversal balances wear on both sets of breaker blocks and eliminates hand-turning of hammers—a major saving in maintenance costs for both parts and labor.

FREE BULLETIN

For full description of Pennsylvania CDL Series Impactors, as well as other Pennsylvania Reversible Impactors, write for Bulletin 6018.



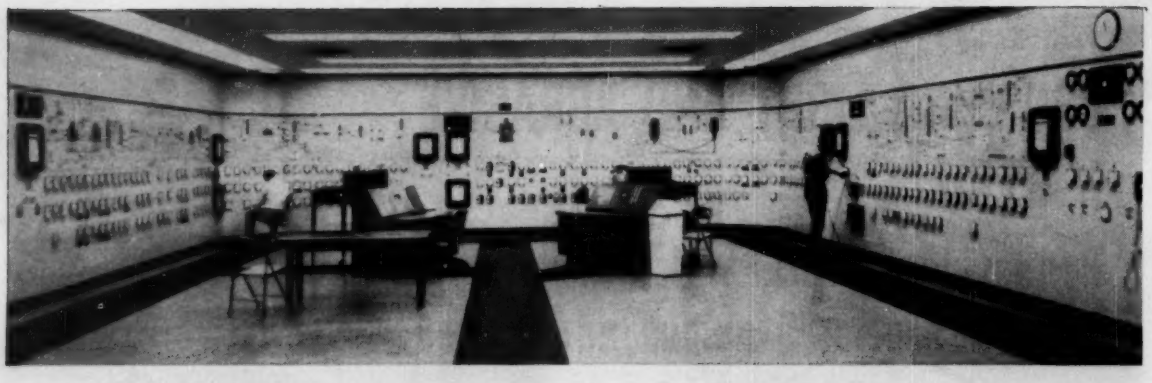
• Pennsylvania CDL 7-38 Reversible Impactor

PENNSYLVANIA CRUSHER DIVISION
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

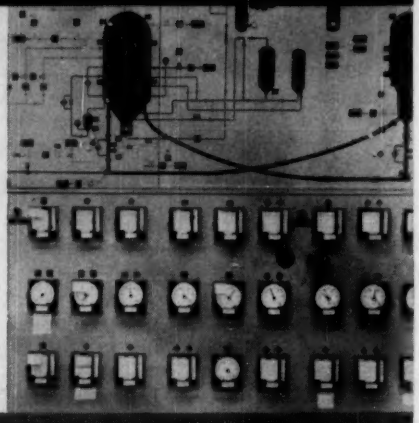
★ ★ ★

Over 50 years' concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.

PENNSYLVANIA
BATH-BUILT
CRUSHERS



Bristol Metagraphic recorders and indicators occupy lower three rows on panel (shown in two photos above). Enlarged panel section is shown below, right.



"NERVE CENTER" AT BIG NEW TEXACO PLANT INCLUDES BRISTOL METAGRAPHICS

This model central control room is the nerve center for a vast petroleum processing complex. It's located in the new Puget Sound Works of Texaco Inc., at Anacortes, Washington.

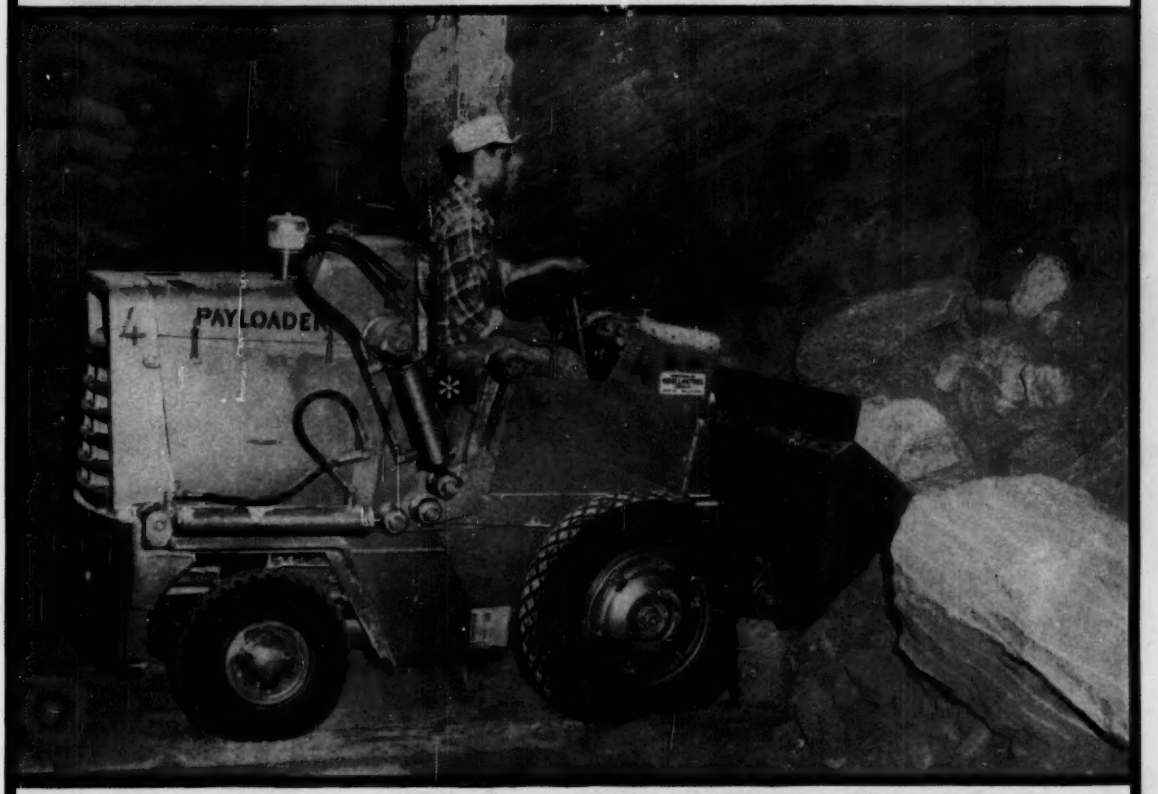
A key feature of the control system is a battery of several hundred Bristol Metagraphic pneumatic recorders, indicators, and controllers (lower three instrument rows on panel). The new plant produces motor gasolines, jet fuels, liquified petroleum gases (LPG), diesel fuel, furnace oil, and heavy fuel oil. Crude oil capacity is 45,000 barrels per calendar day. o.7

This is just one of hundreds of installations of Bristol Metagraphic instruments in use today in processing plants throughout the country. These compact instruments are ideal for graphic panel use, or where true "plug-in" versatility is necessary to insure maximum control system reliability and continuity of service. We'll be glad to send you the complete Metagraphic story. Write: The Bristol Company, 109 Bristol Road, Waterbury 20, Conn.

BRISTOL ... for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

PAYLOADER® is more productive



more digging and breakout power

Unusual digging power is only one feature of the H-25 that makes it the most productive tractor-shovel in its size range. Following are some of the other features and basic reasons why the H-25 "PAYLOADER" is outstanding in its class:

Full Power-shift Transmission with two speed ranges forward and two speed ranges reverse, plus matched, single-stage, two-phase torque converter.

Power-steering and the smallest turning radius (only 6 ft.) in its class.

Power-transfer Differential giving more reliable traction on slippery conditions by reducing drive-wheel spin-out.

Protected for Long Life by the most complete system of built-in insurance: oil filters; triple air cleaners; sealed hydraulic service brakes and enclosed parking brake; closed pressure-controlled hydraulic systems; oil and grease seals; other protective devices.

Whether your bulk-handling needs require the Model H-25 with 2,500 lbs. operating capacity, or larger tractor-shovels — up to 12,000 lbs. operating capacity — you'll find a "PAYLOADER" is the standard of *any* comparison. Your Hough Distributor is ready to prove it, and has the finest service and parts facilities in the business, backed by Hough factory service personnel.

* Two extra-large hydraulic cylinders develop the tremendous bucket breakout, tip-back force of 4,500 lbs. at the cutting edge — more than is available on any other machine in its size range.

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- Easy to Clean
- Superior Flow Characteristics
- Long Service Life
- 65 Sizes to 4" O.D.

You can't beat Tygon plastic Tubing for versatility, efficiency, safety and economy in handling acids, alkalies, oils, greases, alcohols and many solvents. Its unique combination of advantages saves money right from the start.

Flexible, light in weight and available in continuous lengths, Tygon Tubing is quickly and easily put into service . . . ideal for either permanent or temporary installations. Its hard, smooth bore provides a flow equal to larger sizes of some other hoses. And . . . Tygon's wide range of corrosion resistance, its physical toughness, and its non-aging properties, add up to a long, trouble-free service life.

Get complete technical data and other helpful information on Tygon Tubing. Write today for free Bulletin T-100.

PLASTICS AND SYNTHETICS DIVISION

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DEVELOPMENTS . . .

MAY 2, 1960

Chementator

T. PETER FORBATH

Latest firm with a synthetic diamond process: Norton Co. (Worcester, Mass.) A large importer of natural diamonds for abrasive applications, Norton has not yet decided to go into commercial diamond making itself.

El Paso Natural Gas has received Federal Power Commission approval for its Fluor process natural gas-treating plant (Chementator, Mar. 7, p. 53). Facility is now on order from Fluor, will produce 100 million scf./day residue gas, cost over $3 million.

Out of 33,695 engineering bachelor degrees granted in 1959 by ECPD accredited colleges, 3,010 were in chemical engineering. Electricals with 9,837; mechanicals with 8,300; civils with 4,939 topped the ChE's.

MSG: From chemurgy to petrochemistry

Monosodium glutamate is slated to become a petrochemical. Ajinomoto (Tokyo), world's largest producer of the food seasoning with some 20-million-lb./yr. of capacity currently on stream, will start construction in July on an $11-million, 7.2-million-lb./yr. plant to make MSG from acrylonitrile. Facility is expected to be in operation by 1962.

Presently Ajinomoto, as do all MSG producers, makes the popular flavor-livener either by fermentation or chemical extraction of "natural" products such as wheat, corn, beet sugar, sweet potatoes and soybeans (*Chementator*, June 2, 1958, p. 48). But these processes have a built-in feature that, while a blessing to some, can prove to be a bane to others. That feature: Processes turn out large quantities of byproducts—chiefly starch and amino acids—that must be marketed if process economics are to be sound.

In case of Japanese firm, this feature has turned into a bane. Reason: Company's principle outlet for the byproducts—soy sauce manufacture—has become "saturated" while demand for the main product, MSG, has continued to rise steadily. Thus, in order to step up its MSG production without winding up with a glut of unmarketable byproducts, Ajinomoto has turned to the acrylo-based flowsheet.

Firm currently is seeking U.S. patents on its process, thus is reluctant to reveal details. But this much at least is known: Company will buy its raw material from an unidentified Japanese petrochemical firm. Catalytic oxidation of acrylo will produce an aldehyde which then will be reacted with methane and ammonia. Product of this reaction will be hydrolyzed to produce a racemic mixture of glutamic acid from which the levo form will be extracted and converted to MSG.

Various U.S. firms have been looking into similar synthetic routes to MSG. For example, Du Pont has a patent on a process that involves the oxidation of 3-aminocyclopentene

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STUDY
CREATIVE URGE
PROFESSIONAL DEDICATION

produce engineering achievement and accomplishment

Behind the design and manufacturing of Western Heat Exchangers lies the "creative urge" which invariably precedes productive accomplishment in any field of engineering. It is the initiative and creativity of Western's engineering personnel, combined with continuing research into the depths of thermal, mechanical and metallurgical design, that are largely responsible for the universal acceptance of Western heat transfer equipment throughout industry.

Western's engineers await your invitation to collaborate with your own engineers, toward the solution of your next heat transfer problem, however intricate.

WESTERN'S STAKE IN YOUR FUTURE

Your engineers, like ours, must *grow* in their profession, and to encourage their future development, Western is currently publishing a series of messages, as shown at right, in major trade journals. A more complete treatment of each subject is available in pamphlet form, either singly or in quantities, merely upon request. Write today.

One of a series appearing in OIL & GAS JOURNAL, CHEMICAL ENGINEERING, PETROLEUM REFINER, REFINING ENGINEER, CHEMICAL ENGINEERING PROGRESS.

serving the growth of the process industry

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

P. O. Box 1888 – Tulsa, Oklahoma

Personal, professional advancement demands thorough engineering knowledge, disciplined habits, creative thinking, constant application

"Intellectual let-down" — that tendency so common to many engineers to "stop learning" as soon as they acquire a sheepskin — will be completely out of style by 1999. Indeed, it is passe in today's accelerated engineering profession, because to stop learning is to stop growing:

to glutamic acid. Quaker Oats has been studying another Japanese process that starts with furfural. And International Minerals has investigated possibilities of an acrylo-based flowsheet. But present U.S. market situation is such that these processes don't offer attractive economics.

Gas bearings win commercial status

The gas-lubricated bearing, little more than a lab curiosity three years ago (*Chementator*, Mar. 1957, p. 144), has now acquired the two key attributes needed to qualify it for full commercial status. It's being manufactured on a production basis—by Bristol Siddeley Engines Ltd. (London). And it's being bought in quantity by at least one highly satisfied customer—England's Central Electricity Generating Board.

Bristol reports that it's turning out a line of pumps and compressors fitted with hydrodynamic (self-pressurizing) gas bearings of up to 8-in. dia. Machines, with ratings up to 1,800 psi., 700 C. and 1,750 hp., are being installed in all nuclear power stations being built for CEGB, serve primarily to circulate carbon dioxide coolant through reactors.

In these units, a film of gas is drawn between journal and bearing by shaft rotation. (Bearing clearances run about 0.0005 in. for every inch of bearing dia.; gas films are about 0.0001-in. thick.) Gas viscosity increases with temperature, gas-film strength improves with shaft speed and gas pressure. Thus, unlike conventionally lubricated bearings, bearing load capacity of gas-lubricated bearings increases with increasing temperature and shaft speed. Moreover, only wear that occurs is due to viscous drag of gas film or during start-up and shutdown of machines when shaft rotation isn't sufficient to draw gas "cushion" into place. As a result, claims Bristol, gas bearings promise virtually infinite use-life.

Still another attraction of this bearing type, specifically for CEGB's nuclear application, is the fact that there's no problem of lube breakdown due to irradiation.

Atomized suspension tackles atom waste

Atomized suspension technique, which seems on the verge of hustling into a host of industrial applications (*Chem. Eng.*, Jan. 25, p. 56), is also holding out the promise of solving one of the atom's most perplexing problems. Reports General Electric, AST may be the way to get rid of the millions of gallons of radioactive nuclear-reactor wastes now stored in underground tanks.

Operating a pilot AST facility at Richland, Wash., GE researchers have calcined simulated wastes to solids with resulting shrinkage in volume and elimination of the danger of tank leakage. Moreover, AST is better than fluid-bed calcining because of the latter's particle-size instability which can totally disrupt operation. And AST beats screw calciners at the job of radioactive-waste disposal because it's more versatile and less troublesome mechanically, according to GE.

GE's pilot AST calciner, a 10-ft.-high by 8-in.-dia. electrically heated column, handles about 1 gal./hr. of simulated wastes. Feed solution is atomized at column top, then calcines to a fine powder at about 850 C. Volume reduction is about 3:1. Powder can also be collected at bottom of unit and sintered at 900 C. to a massive solid with a volume reduction of 12:1.

Researchers also find that adding phosphoric acid to feed gives powder with a lower melting point (800-1,100 C.) which achieves a volume reduction of 14:1 when melted to a solid. Adding sugar to feed reduces power requirements for calciner by about 80% because of the exothermic reaction of sugar within atomized particles.

Process offers upped gasoline output

Latest to join Universal Oil Products' bulging stable of petroleum processes, the Lomax flowsheet, unveiled at recent Western Petroleum Refiners Assn. meeting in San Antonio (*Chementator*, Apr. 18, p. 79), is being viewed as UOP's answer to Union Oil's Unicracking (*Chementator*, Dec. 14, 1959, p. 74) and California Research's Isocracking (*Chementator*, Nov. 2, 1959, p. 19).

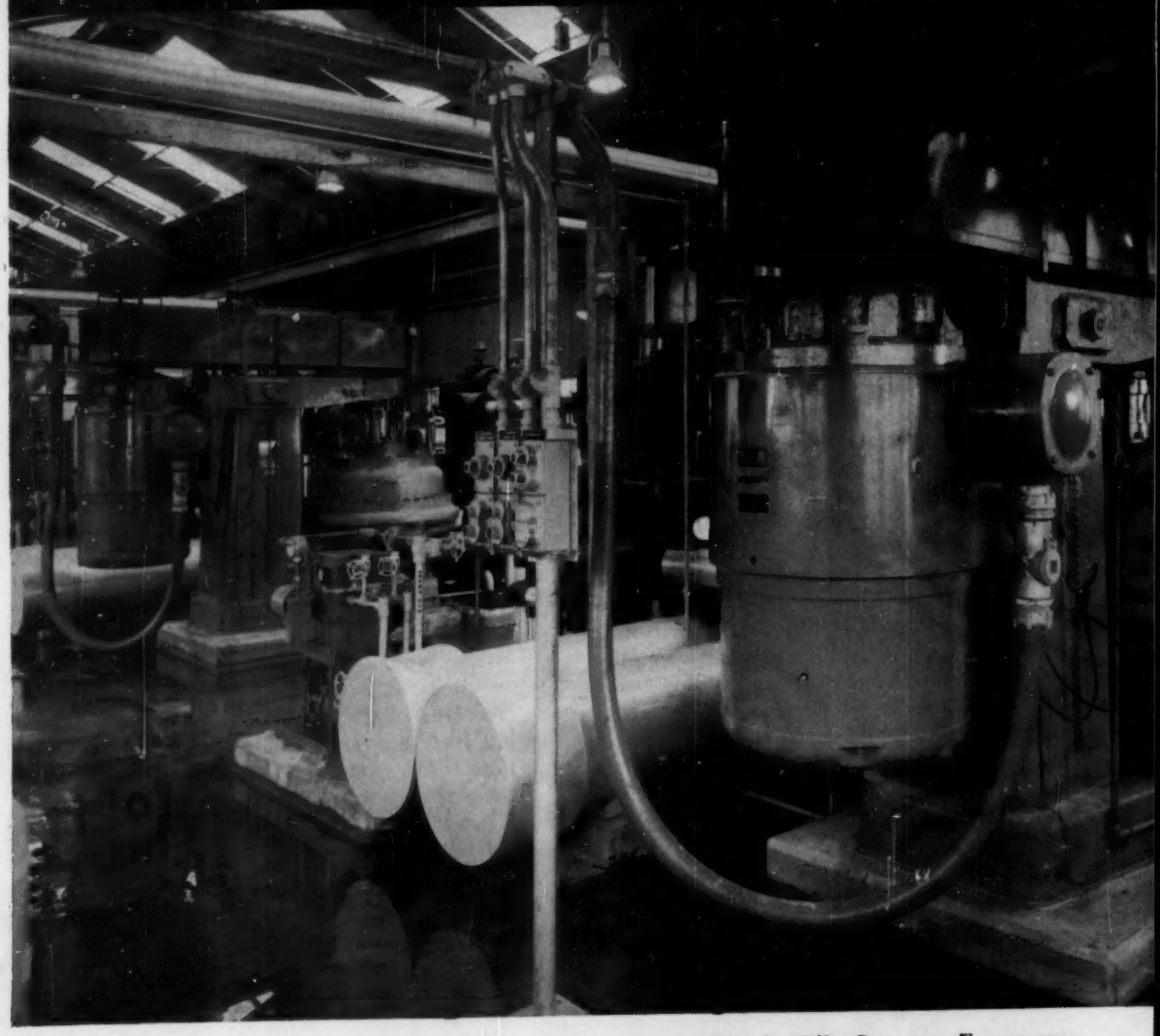
Reason: Lomax, as do the two earlier processes, offers refiners a means of maximizing their gasoline and distillate fuel production while permitting them to use a wide variety of charge stocks (e.g., kerosine, stove oils, vacuum gas oils, coker distillates). Result: Process promises to help refiners match their output more closely to demands.

Carefully skirting any useful details, UOP describes its new flowsheet, now up for

(Continued on page 56)

at Phillips Chemical Company

MERCO PRESSURE CENTRIFUGES *solve catalyst*



removal . . . speed production of high quality linear polyethylene

Volume production of MARLEX®, a high quality linear polyethylene made by Phillips Chemical Company under its own process, depends in large measure upon a fast, economic method of separating the catalyst from the polymer.

Key to this vital purification step is the Merco Pressure Centrifuge, which effectively removes foreign particles as small as 0.5 micron by applying forces thousands of times higher than gravity. Each centrifuge delivers an effluent product of less than 8 ppm impurity at capacities of more than 200 gpm.

Merco Pressure Centrifuges are the first and only units of their type continuously effecting solid catalyst removal on a high production commercial basis. At Phillips—and in several other plants licensed under the Phillips process—these units are operating around the clock, 7 days a week. Many installations schedule only 2 Merco shutdowns per year for maintenance and examination.

Merco Continuous Pressure Centrifuges are revolutionizing many operations in processing industries where high speed, controlled separation is a key to quantity production. Laboratory or commercial scale units are available for trial or demonstration on your products. For complete information, write Dorr-Oliver Incorporated, Stamford, Connecticut.

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licensing, as a catalytic hydrocracking process using a fixed catalyst bed and operating in a hydrogen atmosphere "under pressures such that products are very low in olefins." It converts light distillates into gasoline, heavier vacuum distillates into a variety of middle distillate fuels and/or gasoline. Moreover, compared to conventional cat cracking, process produces no catalyst deposits, a much smaller quantity of light hydrocarbon gases and olefin-free decomposition products, UOP maintains. And it accomplishes all of this at an attractively high degree of efficiency. Declares the company, "Tests indicate conversions of 100 bbl. of oil into as much as 120 bbl. of Lomax product are possible."

UOP visualizes Lomax winning jobs as a supplementary route in existing refineries as well as a basic cracking operation in new installations. For example, Lomax can be used to convert to gasoline the excess light cycle oil from a fluid cat-cracking unit. Or, it can process the virgin distillate streams that ordinarliy go directly to final product pools.

New cracking catalysts from old

Two new fluid cracking catalysts, promising increased gasoline, propylene and butylene yields while retaining the physical and chemical properties of presently available materials, have been developed jointly by American Cyanamid and Shell Development. Labeled Aerocat 3C-12 and Aerocat 3C-20, the new products combine the virtues of silica-alumina and silica-magnesia catalysts into a single silica-alumina-magnesia composition.

Though both materials are now in commercial production by Cyanamid, the first commercial tryout goes to Aerocat 3C-20. Catalyst will be charged to a cat cracker at an unidentified Shell Oil refinery later this year.

Aerocat 3C-12 contains 3% magnesia and 12% alumina; Aerocat 3C-20 appropriately contains 3% magnesia and 20% alumina. Presence of magnesia makes for a catalyst garnering catalytic naphtha yields higher than those possible with straight silica-alumina catalyst, explains Cyanamid. On the other hand, presence of alumina ups yields of propylene, butylene and isobutane above those possible with straight silica-magnesia catalyst.

Furthermore, the new catalysts exhibit somewhat less pronounced carbon-forming characteristics than do silica-alumina products. And, at the same time, properties such as regenerability and resistance to heat and steam are said to be good.

First anti-auto-smog law now on books

California, at last, has the anti-auto-smog law that it has been seeking with an increasing sense of urgency during the past year.

Last month the state legislature passed the nation's first statewide bill designed to combat auto-exhaust air pollution. Law requires all new cars sold in the state to be outfitted with exhaust control devices. And it empowers counties and air pollution control districts to require used cars and commercial vehicles also to be so equipped if a smog problem is ruled to exist in their areas.

Enforcement of the new act has been placed in the hands of California's Dept. of Public Health, which has received a $500,000 appropriation for the job. But it will be a few years yet before the law is actually implemented. Reason: Specific exhaust-control devices have yet to be selected. Currently, a 13-member State Motor Control Board has been created for the purpose of setting standards, testing and issuing approval certificates for anti-smog units. But even when they're chosen, new car owners will have one year in which to have anti-smog devices installed; commercial vehicle owners, two years; used car owners, three years.

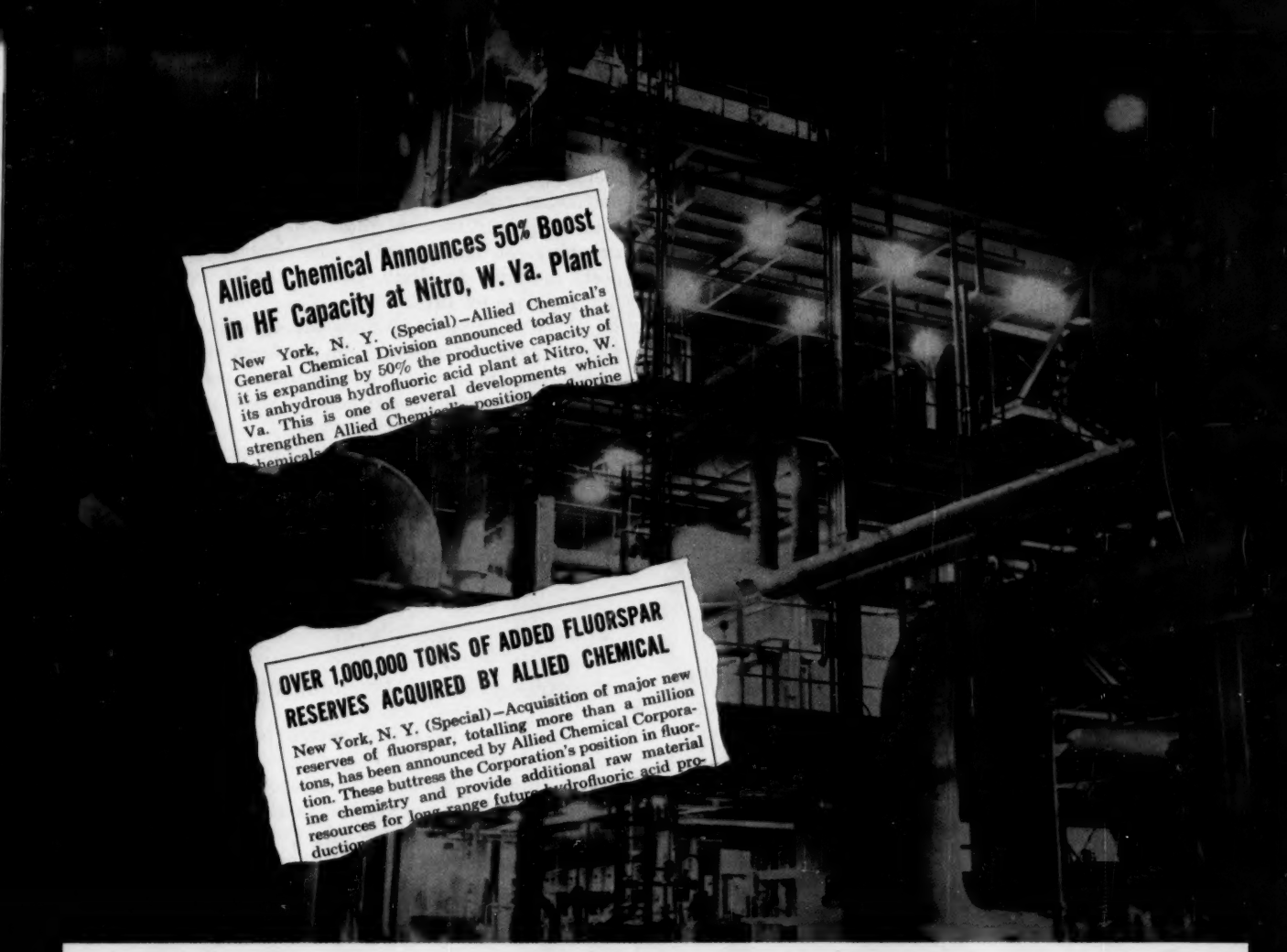
Tomorrow's Technology

Today's embryonic developments which have special significance for chemical engineers

What fuel for fuel cells?

Key to the economic commercialization of fuel-cell power lies in finding the right fuel, declares Allis Chalmers. What that right fuel might be, A-C declines to say. But company feels A-C researchers are hot on its trail, reports that they have under development a new fuel cell that uses an entirely different fuel mixture which will be harnessed shortly to the job of powering a fork-lift truck.

What A-C believes the right fuel *not* to be, is revealing if for no other reason than its iconoclastic inclusiveness. Company research supervisor, T. G. Kirkland, tells *CE* that A-C is satisfied that the right fuel is not the propane mixture that A-C uses in its


Allied Chemical Announces 50% Boost in HF Capacity at Nitro, W. Va. Plant
New York, N. Y. (Special)—Allied Chemical's General Chemical Division announced today that it is expanding by 50% the productive capacity of its anhydrous hydrofluoric acid plant at Nitro, W. Va. This is one of several developments which strengthen Allied Chemical's position
OVER 1,000,000 TONS OF ADDED FLUORSPAR RESERVES ACQUIRED BY ALLIED CHEMICAL
New York, N. Y. (Special)—Acquisition of major new reserves of fluorspar, totalling more than a million tons, has been announced by Allied Chemical Corporation. These buttress the Corporation's position in fluorine chemistry and provide additional raw material resources for long range future

2 More Big Reasons for Making General Chemical *Your HQ for HF*

General Chemical recently announced two developments of interest to every consumer of hydrofluoric acid—a 50% increase in anhydrous HF capacity at Nitro, W. Va., and the acquisition of more than 1,000,000 tons of additional fluorspar reserves. Both announcements underscore General's position as the nation's leading supplier of aqueous and anhydrous hydrofluoric acid.

Here are more good reasons why it pays to make General *your HQ for HF:*

Eight HF supply locations, three producing plants! General Chemical maintains eight HF supply points. Of these, three plants located in North Claymont, Delaware; Baton Rouge, Louisiana; and Nitro, West Virginia, make General Chemical the *only* supplier offering shipment of anhydrous as well as aqueous from more than one producing location.

In addition, General Chemical maintains five aqueous HF bulk storage and packaging stations at Buffalo, N. Y.; Chicago, Ill.; Cleveland, Ohio; El Segundo (Los Angeles), Calif.; and Pittsburgh, Pa. These five points back each other up and further assure service and availability of HF at all times, under all conditions.

Basic position! General Chemical owns and operates its own fluorspar mines and mills . . . and is the country's leading producer of sulfuric acid. This basic position in the essential raw materials for hydrofluoric acid production is your best assurance of dependable supply.

If you'd like more information as to how we can serve you, just drop us a line. Why not do it now?

Basic to America's Progress

Allied Chemical

GENERAL CHEMICAL DIVISION

40 Rector Street, New York 6, N. Y.

fuel-cell-powered tractor (*Chementator*, Nov. 2, 1959, p. 24). Nor is it hydrogen, which fuels the vast majority of fuel cells around today such as those of Universal Winding, National Carbon, General Electric. Nor is it a methane-type mixture, which is frequently eyed by researchers because of its low cost.

Despite this view, another "conventionally fueled" fuel cell has made an optimistic appearance on the crowded fuel cell scene. Ionics, Inc., reports developing a fuel cell using "ordinary hydrogen gas and unpurified air," is studying other fuels.

Low-cost steels seek atom job

Recognizing high capital cost as the single most powerful reason why nuclear energy continues to be an economic bust in this country, U.S. Steel and General Electric have launched a joint research program to determine if the high-cost stainless, columbium and other "exotic" alloys now used in atomic reactors can be replaced with low-cost steels. And, while their studies are still in the earliest stages, their preliminary findings indicate that carbon and low-alloy (up to 5% chromium) steels look like they can stand up satisfactorily to corrosion and radiation conditions in boiling water reactors.

Declares a spokesman for the USS-GE research team, use of low-cost steels in a typical $45-million, 300-megawatt reactor would garner savings upwards of $2 million. But more than that, these steels would also offer advantages over stainless such as (1) lower thermal expansion and heat-transfer characteristics, (2) greater availability in quantity and "on-the-shelf" equipment, (3) less serious radioactive problems from corrosion products and (4) elimination of stress corrosion cracking problems in reactor design.

Radiation processing: What's ahead?

Several experts held forth recently on the controversial topic of radiation processing. Their collective opinion: While radiation is winning acceptance for specialized applications, it's far from becoming the universal tool some have predicted it would be.

Reviewing the radiation literature for the Nuclear Congress in New York last month, A. J. Restaino of Atlas Powder concluded that the most promising outlook for radiation is in modification of natural and synthetic polymers. Application of high-energy radiation for petroleum cracking and sweetening isn't encouraging. But costs of radiation sources are dropping, he noted, and if chemical process costs continue to climb, then radiation may find its place by 1970.

F. W. Lampe of Humble Oil, speaking at the Western Petroleum Refiners Assn. meeting in San Antonio, emphasized that researchers should use radiation to achieve results that can't be attained any other way. "Don't shoot every chemical on the lab shelf," he stressed. For reactions with G-values (molecules formed/100 e.v. absorbed) of 1,000 and feed with a molecular weight of 30 (ethane-ethylene range), Lampe estimates radiation cost for one-ton/day unit at about 8¢/lb. Soon, however, for a 30-ton/day unit, costs should be down to about 2¢/lb.

Research and development briefs

Another "fuel brick" is reported by Russians. This one, butane brick, is produced by mixing liquid butane with urea-formaldehyde resin, polyvinyl alcohol, casein and glycerine. Earlier (*Chementator*, Oct. 19, 1959, p. 100), Soviets claimed development of gasoline bricks.

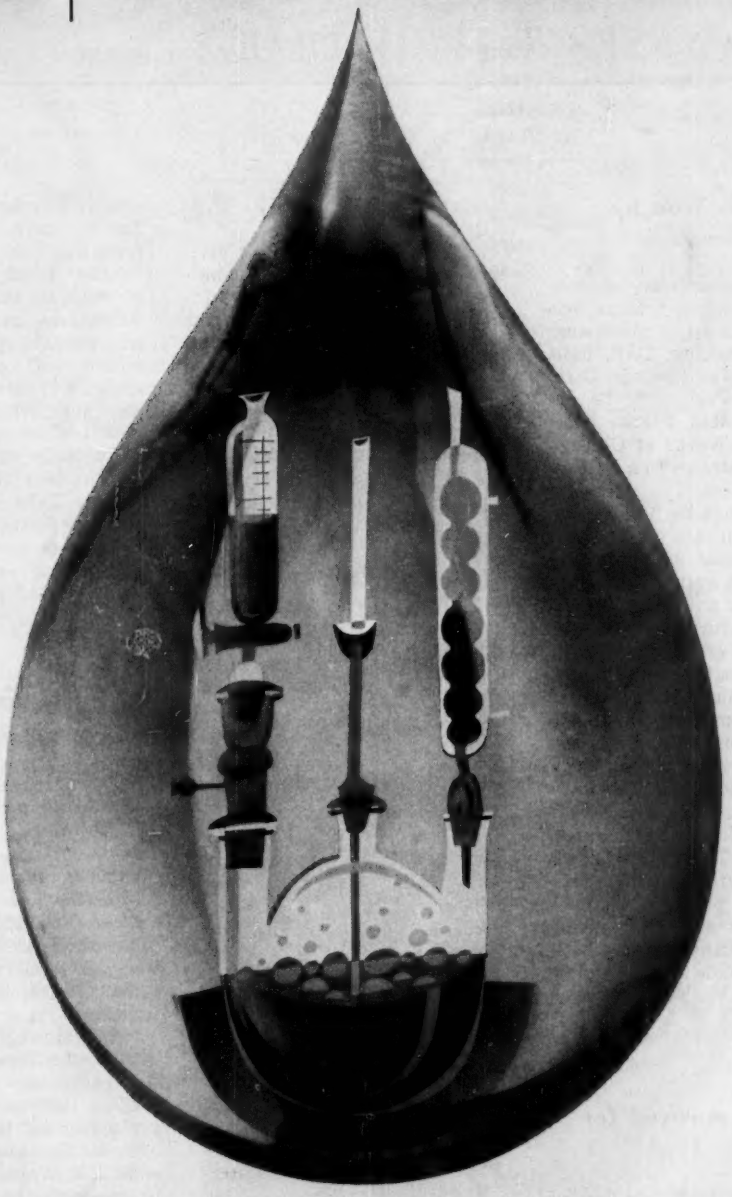
New high-speed encapsulation machine has been developed at Southwest Research Institute (San Antonio, Tex.). Unit can turn out capsules as small as 30 micron dia. at rate of 500/hr. Older machines operate at considerably slower rates, can produce capsules not much smaller than 300 micron dia.

An ice "alloy", made by reinforcing pure ice with 4% by volume glass fiber, has come out of Ice Research Lab of Massachusetts Institute of Technology. Working under $100,000 Air Force contract, MIT researchers find that this material is 10 times stronger than pure ice. Air Force believes it has utility as construction material for Arctic locations.

Polymerization of acrolein is being given some new twists by Degussa (Wolfgang, Germany) researchers. Under study: Copolymerization of acrolein with materials such as epoxies, butadiene, methacrylates, ethylene, propylene, and styrene. These reactions promise creation of new, highly attractive plastics.

For more on DEVELOPMENTS.....60

DOW | **BROMINE DEVELOPMENTS**



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Every chemist can name a long list of examples. Even so, imaginative research continues to provide new brominated compounds for new uses as intermediates in both organic and inorganic chemistry. The result: new efficiency for old processes . . . and the creation of new processes. Brominated compounds are also attracting new attention for building dense fluids and for extinguishing fires.

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DEVELOPMENTS . . .

PROCESSES & TECHNOLOGY

C. S. CRONAN

Another Job Won by Axial Compressors

An axial compressor, in combination with a gas turbine, has been named to a key processing job in steel making. Unit, built by Westinghouse Electric Corp. (Pittsburgh, Pa.), will be installed in United States Steel Corp.'s South Works at Chicago to supply air stream to a battery of blast furnaces.

Axial will handle 125,000 cu. ft./min. for furnace blast. Moreover, it will also supply air to the combustion system of the gas turbine which will be fueled by recycle blast-furnace gas. According to Westinghouse, axial compressor-gas turbine combination is lower in initial cost than conventional methods of blast-furnace blowing. It requires less space, eliminates the need for a steam boiler and uses practically no water.

To date, axials have won processing jobs in Texas Butadiene & Chemical's butadiene and aviation gasoline plant in Channelview, Tex., at Allied Chemical's nitric acid plant in Hopewell, Va., and at Linde's oxygen plant at Duquesne, Pa. (*Chementator*, April 4, p. 57).

Standard Approved for Polyethylene Pipe

Plastic pipe standardization—a long neglected area—is finally getting the attention it deserves.

The Society of the Plastics Industry has recently approved a new commercial standard for schedule 40 polyethylene pipe covering low, medium and high density material.

Proposed standard incorporates performance requirements—including pressure and environmental cracking. SPI expects this standard will be adapted as a revision to existing polyethylene standard CS 197-59 (U. S. Dept. of Commerce).

SPI's thermoplastic pipe division is also working on an engineering manual which will include installation techniques for all types of plastic pipe now used by industry.

In addition to the polyethylene standard, four others have been issued by the Dept. of Commerce: CS 207-60 (PVC), CS 218-59 219-59, 220-59 (all on rigid ABS, acrylonitrile-butadene-styrene).

FATIGUE TESTS vibrate pipe at natural resonance.

Resonance Bending as Pipe-Testing Technique

Tube Turns Div. of Chemetron Corp. (Louisville, Ky.) reports that it has successfully applied the concept of resonance bending to the job of determining the service life of metal pipe. Outstanding feature: Technique slices the time required to make such tests by conventional methods (e.g., cyclic bending or pulsating water) by a large factor of six.

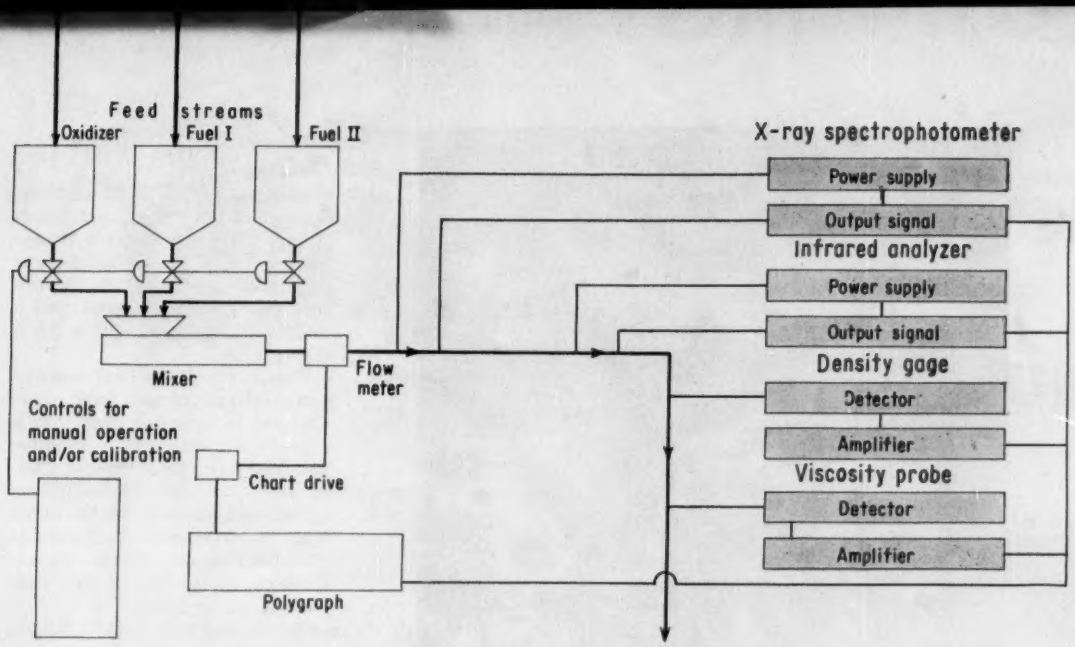
Explains a company spokesman, resonance bending involves setting lengths of pipe to vibrating in their natural resonance frequency until they literally "shake" themselves to the point of fatigue failure, then crack. Vibrations, generated by eccentric weights spun by an electric motor, of several thousand cycles/min. are attained. Carbon steel pipe with ¼-in.-wall thickness can be vibrated at about 4,300 cycles/sec. to fatigue failure in less than a half hour, reports Tube Turns. This simulates stresses encountered in "years" of service in industrial plants and cross-country pipelines.

Stauffer's Move Into Trona Meets New Blocks

New roadblocks are being thrown up in the path of Stauffer Chemical Co. as it tries to develop a major soda-ash-from-trona operation on Federal land at Green River, Wyo. (*Chementator*, Feb. 22, p. 51). Company has declared its desire to build a $20-million, 1,200-ton/day plant on a 6-12,000-acre trona deposit.

Initial problem Stauffer faced: Obtaining lease to this land since it represents part of an ambitious land-reclamation project planned by the Wyoming Natural Resources Board. Now Hills & Wagner, Denver (Colo.) geologists, has filed application for lease of 60,000 acres of oil-shale lands that take in the property eyed by Stauffer.

Stauffer has been seeking to work out arrangements that would insure that its trona-mining operations would not interfere with the reclamation project, so hurdle the first difficulty. But company representatives have told the Wyoming board that oil-shale developments would not be compatible with trona mining.



Missile Sparks Continuous Mixing Gains

To make solid fuel for Polaris naval missile processor sets up first continuous propellant line and brings "stream" techniques to paste mixing.

To manufacture propellant for the U. S. Navy's new Polaris submarine missile and other advanced-design rockets, Aerojet-General Corp. is now operating the first continuous propellant process in a new facility recently completed at Sacramento, Calif.

With this new facility, Aerojet-General has shifted propellant compounding from a typical batch paste-mixing operation to closely controlled continuous stream flow like that common to liquid and gas processing.

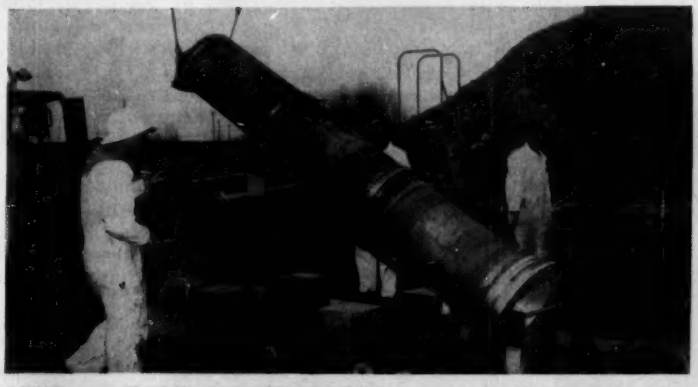
▶ **Better Several Ways**—According to the Navy, Aerojet's shift to continuous processing produces higher-grade, more uniform propellant with greater safety and at lower cost.

Already, the Navy has proved out quality by test-firing successfully over 100 small-scale Polaris static test vehicles and by launching a full-scale missile down the Atlantic test range from a surface vessel in March.

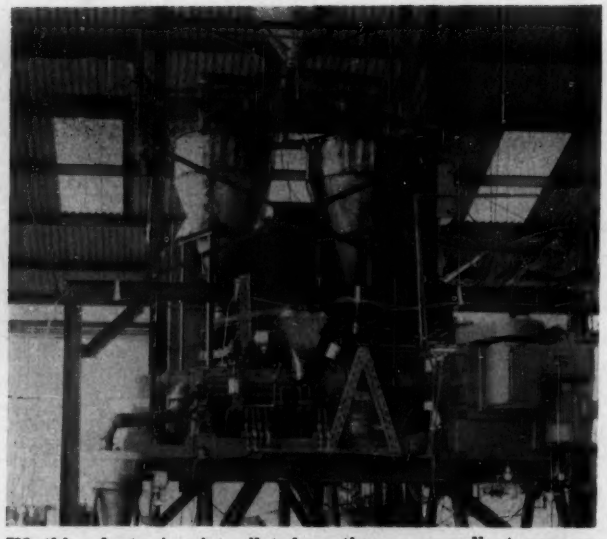
With such performance now proved, propellant development seems in good shape to meet the demands imposed by speedup in the Polaris program which aims to cut 2-4 mo. from schedule of the $2.75-billion project.

▶ **Economical Safety**—From the standpoint of stepping up propellant output safely at reasonable cost, Aerojet's new plant is well designed.

In its older process, Aerojet prepares propellant in 2,200-lb.



SOLID propellant from continuous plant passes test in segmented rocket.



IN this plant, Aerojet piloted continuous propellant process.

batches which have the destructive potential of 2,200-lb. bombs. But the new continuous system holds only 20-25 lb. in process, so that any minor explosion or fire can't knock out plant.

Labor charges for batch processing run approximately 18¢/lb., with no decrease at high output. By mixing continuously, Aerojet cuts labor charges to 3¢/lb. So, continuous mixing is the only practical way to supply large quantities of propellant needed for Polaris and other large missiles.

▶**Eye to Future**—When Aerojet talks about other large missiles, it means those in thrust range above 1 million lb.

In this range, rockets now under development are too large to be moved on the ground. So, they must be loaded in segments which can be moved to launching site and assembled. Or, the propellant must be mixed and loaded into the rocket case at the launching site.

However, on-site mixing and loading is not practical either in terms of cost or safety. Before curing, high-energy solid propellants must be handled very carefully, which is virtually impossible at a rocket launching site claim Aerojet spokesmen.

After curing, these propellants can withstand handling shock incurred in transporting. For that reason, Aerojet feels that its permanently installed continuous process with adequate processing safeguards could satisfy solid-fuel requirements for large rockets. Loaded into rocket segments and cured, Aerojet's propellant could be transported.

▶**Standard Equipment**—In putting together the continuous system, Aerojet worked with commercially available equipment, for the most part, and set an enviable elapsed-time record in doing so. Piloting was completed in 40 weeks. After 3 mo. for design, Aerojet's Architect-Engineering Div. took only 150 days to construct plant.

At Sacramento, Aerojet meters propellant components continuously into an interrupted-flight continuous mixer which blends them uniformly into a high-energy rocket fuel. A series of monitors on the discharging stream of paste assure that the mixture stays within product specifications.

▶**Component Streams**—Components feeding into the system are oxidizer, main fuel and final fuel.

Ammonium perchlorate oxidizer is conditioned in 10,000-lb. lots to remove surface moisture. Then, grinding reduces it to a particle-size distribution which will give optimum packing and good castability.

From grinder, oxidizer moves at 100-150-lb./min. rate to surge hopper via pneumatic system using 1 lb. of dry nitrogen fluidizing gas per 25 lb. of oxidizer. Until oxidizer enters continuous mixer, it is kept under nitrogen blanket. Feeding from hopper into mixer is handled by duplex loss-in-weight feeder which maintains feed rate within 0.5% of set point.

Fuel, which is commercial polyurethane, comes from storage and is weighed first into a shear-type dissolver by simplex loss-in-weight batch feeder. Additives such as polypropylene glycol and carbon black blend with polyurethane in dissolver. Finished blend then passes through duplex feeder into continuous paste mixer.

Final fuel, a liquid stream such as toluene diisocyanate containing polymerization agents, goes through degassing and gear type metering pump into continuous mixer.

▶**Monitor Mixing**—Interrupted flight, continuous mixer is water jacketed and controlled at 80 F. to deliver propellant at 5,000-cps. viscosity. Leaving the mixer, this propellant passes four stream analyzers which check quality of the mixture.

First, an x-ray spectrophotometer checks the proportion of oxidizer by monitoring for chlorine in the ammonium perchlorate. Then, an infrared analyzer measures the ratio of one fuel component to the other. A beta-ray gage measures density and an ultrasonic device checks viscosity.

Monitor-signals feed into remote control center. Eventually, Aerojet hopes to upgrade these stream-analyzer monitors into a closed loop with computer control.

Once past the stream monitors, material discharges into batch buggies which move it to the casting area where it is placed in the rocket casings and cured at 110 F.

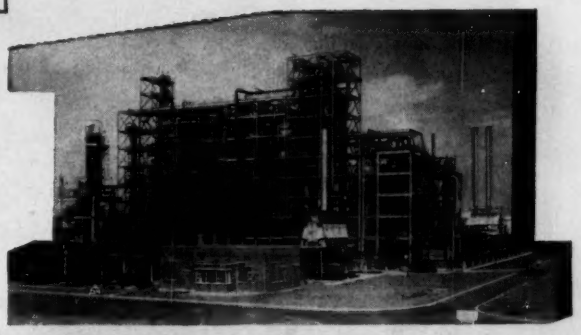
▶**Fewer People**—Critical areas are under surveillance by TV, using only five operators for entire process where older batch plant requires 28 men.

To complement lower manpower, Aerojet expects also that installation cost for a continuous plant of this type over the next several years will be the same or less than an equivalent batch plant.

KELLOGG BUILDS FOR I.C.I. EXPANSION

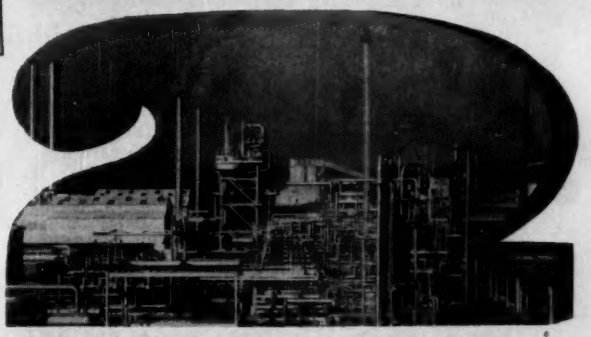
1951

Recent completion of Imperial Chemical Industries' third olefin plant at Wilton, England, has made these Works the largest petrochemical venture outside the United States. With a current output of 110,000 tons per year of high-purity ethylene, and a potential output of 140,000 tons, I.C.I. Wilton is an outstanding example of engineering cooperation.



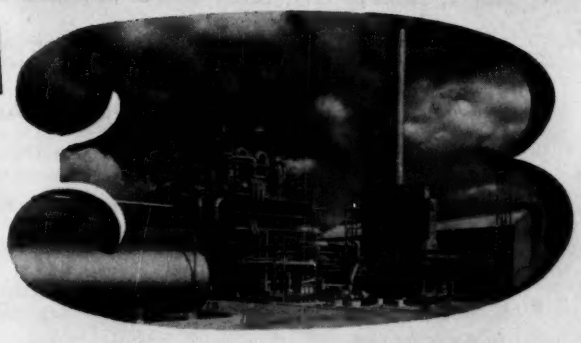
1956

The first plant was commissioned in 1951, and was the first full-scale adoption of the then novel process of oil pyrolysis developed in the Kellogg Laboratories. Its success led to the addition of No. 2 plant in 1956, and then to this latest extension, representing a 60% increase in olefin capacity, in 1959.



1959

Cooperation between client and contractor is the keynote of Kellogg's contribution to chemical engineering. The Wilton Olefin Plant is the largest in the world based on liquid feedstock. Kellogg is proud to have been associated with its development.



To learn more about Kellogg's background in engineering and building olefin plants, at home and overseas, write for current Kelloggram

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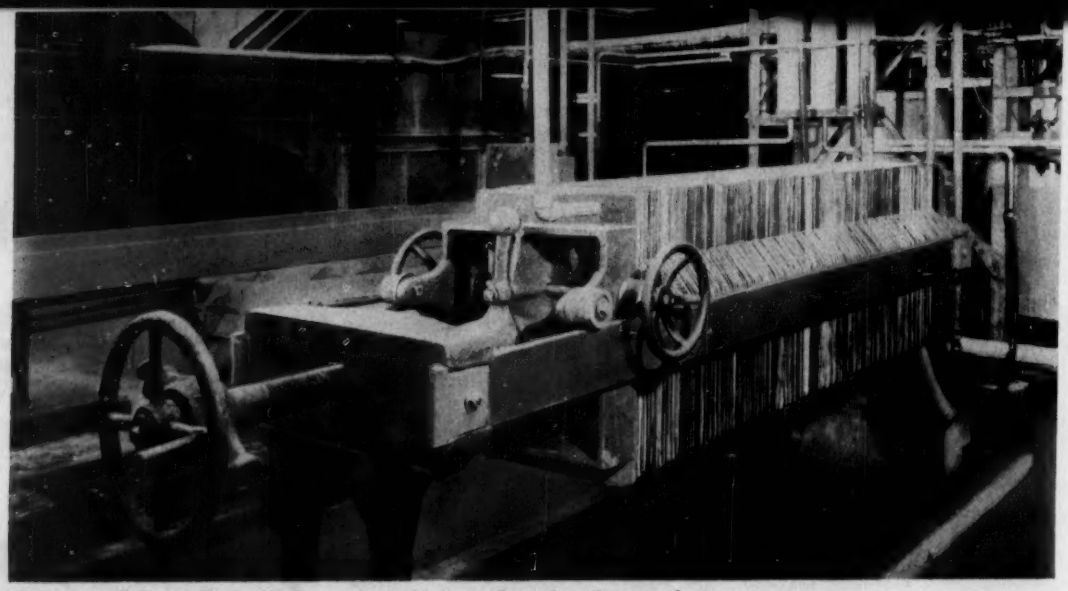

WITH this dialyzer, Phelps Dodge strips acid from electrolyte for recycle to process.

Dialysis Breaks Acid-Recovery Barrier

Overcoming serious membrane deficiencies, dialysis now claims solid success in recovery of sulfuric acid from process liquors.

A big factor in recent budding of the long-neglected unit operation of dialysis has been its use by Phelps-Dodge Refining Corp., to recover H_2SO_4 from some process streams at its Laurel Hill, N. Y., works. Following articles on dialysis equipment (*Chem. Eng.*, Jan. 12, 1959, p. 84) and basic fundamentals (*Chem. Eng.*, May 4, 1959, p. 117), here's a look at how Phelps-Dodge has fared in plant practice with the operation.

With a background of pilot plant experience gained in 1947-1948, the company started using dialysis in its $NiSO_4$ plant in 1957. Following progressive refinements there, the operation was moved into the $CuSO_4$ plant, as well, the next year.

Program has apparently been regarded a success, as Laurel Hill experience has led to installing dialyzer capacity at the company's El Paso Refinery.

▶ **A Look at Theory**—In dialysis, components of a liquid solution are separated by selective diffusion through a membrane to a solvent. Suitable membrane material is important, as the

Laurel Hill Unfolds Data for Dialytic Acid Recovery

	$NiSO_4$ Plant			$CuSO_4$ Plant (Nalfilm D-30)	
	Parchment 1957	Nalfilm 4 1957–1958	Nalfilm D-30 1958–	With Preconcentration	Without Preconcentration
Dialyzer feed liquor:					
gpm	3.11	2.94	2.36	7.24	7.30
g./l. free acid	240.6	290.5	295.9	294.9	247.5
Acid transfer rate, lb./hr.-sq. ft.	0.113	0.151	0.304	0.275	0.169
Acid transfer coefficient, lb./hr.-sq. ft.-(g./cc.)	0.801	0.858	1.47	1.744	1.072
Acid product stream: (diffusate)					
gpm	2.64	2.86	1.87	7.08	7.15
g./l. free acid	73.1	89.4	82.3	112.1	76.6

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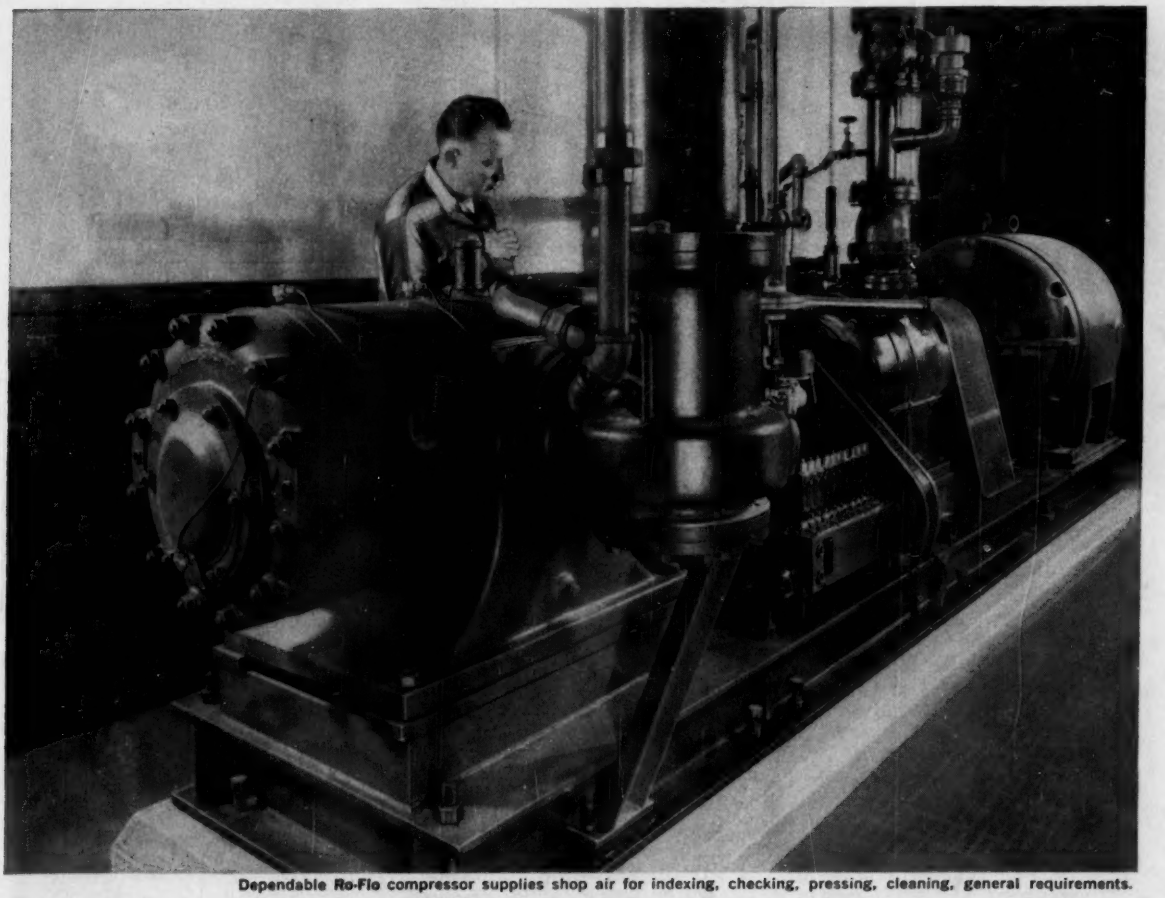

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Record-breaking run in Allegan

no new parts for this RO-FLO compressor since installation

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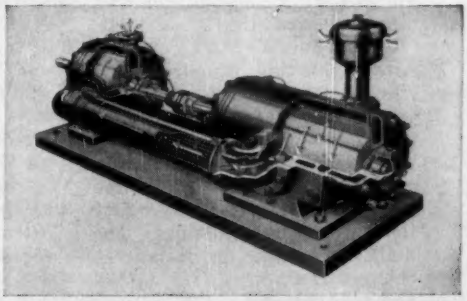
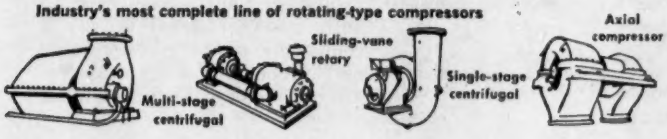
Ask your A-C representative about low-noise, low-maintenance *Ro-Flo* compressors. Or write **Allis-Chalmers,** Industrial Equipment Division, Milwaukee 1, Wisconsin.



Sliding-vane action compensates for blade wear, helps maintain constant efficiency. Rotary motion cuts vibration and noise, eliminates shock and the necessity for expensive foundations. *Ro-Flo* is an Allis-Chalmers trademark. A-1306

Industry's most complete line of rotating-type compressors



membranes need a high diffusion capacity as well as ruggedness and strength.

A convenient measure of dialyzer performance is rate of component transfer, lb./hr.-sq.ft. Another is the transfer coefficient, which takes into account the log mean concentration gradient — or driving force — across the membrane.

Each solute has its own rate and coefficient in a given dialysis setup. Good performance means extracting a suitable amount of the wanted solute and as little as possible of other components, giving a dilute but fairly pure solution of the desired solute.

▶**Early Experience** — Phelps-Dodge's pilot plant dialyzer of 1947-1948 treated a $NiSO_4$-H_2SO_4 electrolyte stream of refinery series-system liquor. Solvent was water, as was the case in all subsequent work described below. Membrane consisted of 850 sq. ft of parchmentized kraft paper.

Process extracted H_2SO_4 satisfactorily, but the operation wasn't considered practical since the membranes required frequent replacement. So, the plant was shelved and little work was done for about eight years.

▶**Next Application**—In 1956, the company decided to give dialysis another try, this time in the $NiSO_4$ plant where a smaller volume of liquid was involved. The same dialyzer, again with parchment membrane, was used. Feed liquor again contained $NiSO_4$ and H_2SO_4; it also contained significant amounts of impurities, mainly sulfates of Fe, As and Sb.

The setup operated for some six months, actively on stream about 60% of the time. Membrane service was again a problem, as 45 membrane changes were needed during the period.

▶**Enter New Membranes** — Around this time, promising new vinyl membrane materials were being developed. Phelps-Dodge tried one of them, Nalfilm 4 developed originally for ion exchange, and the first three months of operation proved that the switch was justified. The dialyzer needed no membrane changes at all during the period, and acid transfer coefficient rose somewhat. The decreased downtime meant that the unit now provided overcapacity, and generally it was used only 2-3 days/week.

Operation with Nalfilm 4 continued for a year. During this time a new vinyl material, Nalfilm D-30, was developed which had no fixed ionic group. Laboratory tests pointed to a much higher acid transfer coefficient, and the company decided that a switch to Nalfilm D-30 was in order.

As the existing unit already provided overcapacity, it was decided to go also to a smaller dialyzer with about one-third as much membrane surface.

Again the change was for the good. Acid transfer took a big jump upward (although not as big as expected from lab data—this was attributed to sludge formation in the plant unit), and the new unit showed compactness and economy of design compared to the former one.

▶**Wider Fields**—In 1958 Phelps-Dodge extended dialysis to the $CuSO_4$ plant, to purify tank room discard liquor. This involved buying two new units with 1,700 sq. ft. combined membrane surface; the original unit from the $NiSO_4$ plant was also used.

At first the feed liquor was preconcentrated by evaporation, with a high acid-transfer coefficient again being exhibited. A final step was to operate in the $CuSO_4$ plant without preconcentration. This meant some sacrifice in capacity, but it added process simplicity and did away with evaporator maintenance.

▶**Wrapping It Up**—Performance data for these installations, given in the accompanying table, show the improvements in acid transfer coefficient upon changing membrane materials or dialyzers.

$NiSO_4$ plant data showed that Ni transfer increased along with acid transfer, sometimes at a greater ratio. This drawback, however, didn't outweigh the over-all improvements experienced.

The Phelps-Dodge operation has proved to be a simple way to extract acid from plant streams, requiring a minimum of operating labor.

Story based on "Dialysis in Extractive Metallurgy" by Tuwiner and Smith presented at AIME meeting, Feb. 15, 1960.

More Nylon-6 for Tire Cord Slated

Expansion of nylon-6 production capacity, chiefly spurred by the tire-cord market, continues at a determined pace. American Enka Corp., a leading rayon-for-tire-cord maker, is the latest to join the parade. Company announced last month that it plans to expand its nylon-6 heavy-denier-yarn production by an additional 3 million lb./yr. at Enka, N. C. This, together with production already slated to be on stream this fall, will give Enka a total capacity of 6.5 million lb./yr.

Private Production of Liquid Helium Now Set

Private production of liquid helium, once the exclusive business of the Federal government's Bureau of Mines, is set to begin this month. Air Products, Inc. (Allentown, Pa.) has completed construction of a commercial-scale facility at Iselin, N. J. Product will be shipped by truck in specially designed vacuum-insulated containers throughout an area of 600-mi. radius. Too, shipments by air freight over a much larger area are planned for the near future.

In addition to the helium, Air Products will also produce liquid hydrogen at the Iselin plant. Facility is so designed as to permit either one or the other product or both being manufactured. The low-temperature materials are aimed at cryogenic applications in electronic and missile fields, for research at university, industrial and institute laboratories.

New Anodizing Process Colors Aluminum Sheet

Kaiser Aluminum & Chemical (Oakland, Calif.) has come up with what's claimed to be "a completely new anodizing process" which produces a wide variety of colors of high stability

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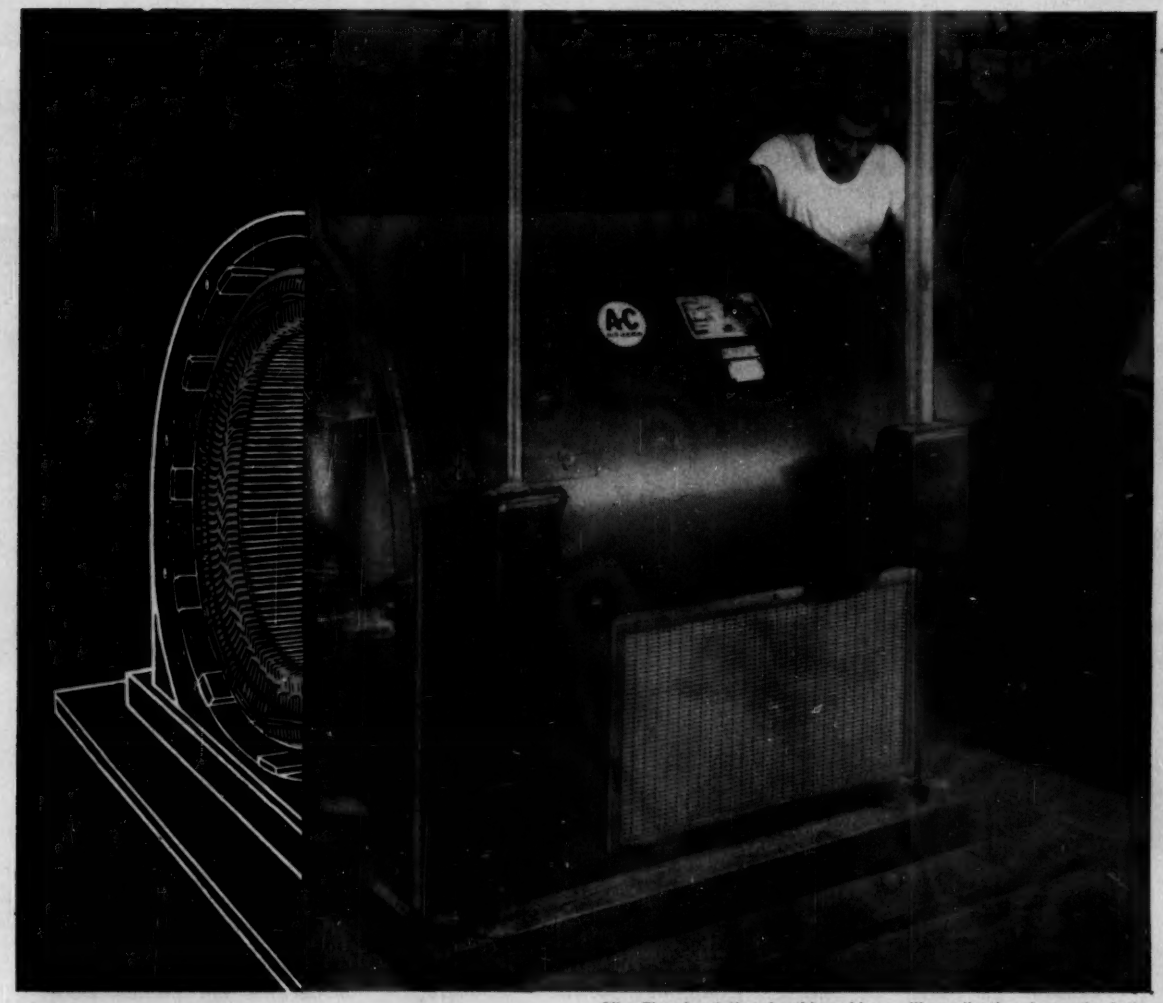

Silco-Flex insulation in this rubber mill application has solved the problem of carbon black—one of the worst enemies of motor insulation.

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They contribute to the invisible standards that protect your motor investments year after year — cut replacement costs — assure uninterrupted production.

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Super-Seal and Silco-Flex are Allis-Chalmers trademarks.

and uniformity on aluminum. Process, called kalcolor, employs no organic dyes, was developed specifically for use with architectural aluminum alloy extrusions and sheets. Colors currently available include gold, amber, tan, brown, olive, gray and black.

Tones are created by conversion of alloying elements within the metal itself, explains Kaiser. As a result, excellent color uniformity in anodic coating is achieved. Too, corrosion and abrasion resistance of coating are said to be decidedly superior to those of conventional anodizing processes. Kaiser has licensed the process to more than six metal-finishing firms, company reports.

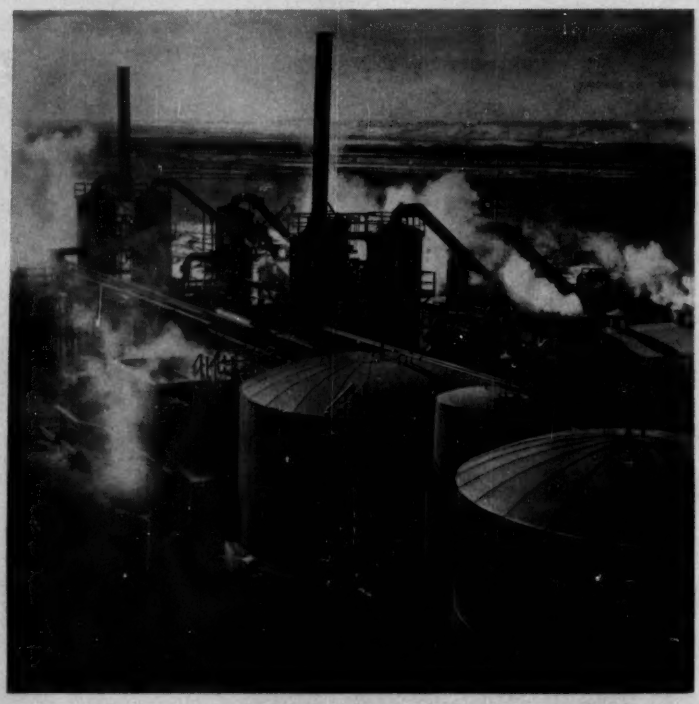
New Anti-Smog Device Gets Strong Backing

A new device for combating smog produced by automobile exhausts is now getting strong backing from the Los Angeles Board of Supervisors. And there's a strong possibility that new California legislation may make it mandatory that this anti-smog device be installed on all 1961 cars.

Developed by the L.A. Air Pollution Control District and the University of California (Los Angeles), device involves introducing a small amount of cooled exhaust gas into the intake manifold of auto engines. This controls amount of nitrogen oxides in motor vehicle exhausts. Device reportedly would cost about $2/vehicle.

Board of Supervisors' chairman, Frank Bonelli, believes that this device "may be a real breakthrough in our battle against smog." Board has adopted motions to (1) urge federal and state officials, as well as auto manufacturers, to do whatever necessary to have the device installed on all 1961 model cars and (2) authorize Pollution District and UCLA scientists to go to Sacramento to testify on current bills before state legislature for the control of motor-vehicle emissions.

INDUSTRY NEWS



SULFURIC ACID capacity on the increase at Susquehanna-Western.

Susquehanna-Western, Inc. has placed on stream new capacity at Riverton, Wyo., to increase its sulfuric-acid potential to 75,000 tons/yr. Rising demand for sulfuric acid by local ore-processing, oil refining and fertilizer producing industries spurred the plant expansion; Susquehanna Engineering Co. constructed the new facilities in a record four months.

American Chemical Corp. is now operating its new chlorinated hydrocarbon plant at Long Beach, Calif. American Chemical produces ethyl chloride, vinyl chloride and ethylene dichloride at this new $7-million plant.

Hooker Chemical Corp. broke ground for an enormous, $6.4-million expansion of its Columbia, Tenn., phosphates plant. Addition of a third furnace to reduce phosphate rock will up Hooker's phosphorus capacity to 65,000 tons/yr.; to facilitate increased production, Hooker also plans to add an unusually large kiln and modernize the plant's complete materials conveying system.

Texas-U. S. Chemical Co. has begun a major expansion program of its Port Neches, Tex., copolymer plant to increase capacity by 10% to 156,000 tons/yr. New drying and carbon-black batching units will permit an increase in butadiene-styrene rubber output.

Anaconda Uranium Co. has started injection of radioactive wastes into its 1,780-ft.-deep wastes well at Grants, N. M. This first well for radio-

Industry News continues on page 156.

THE ECON-O-MISER BALL VALVE...

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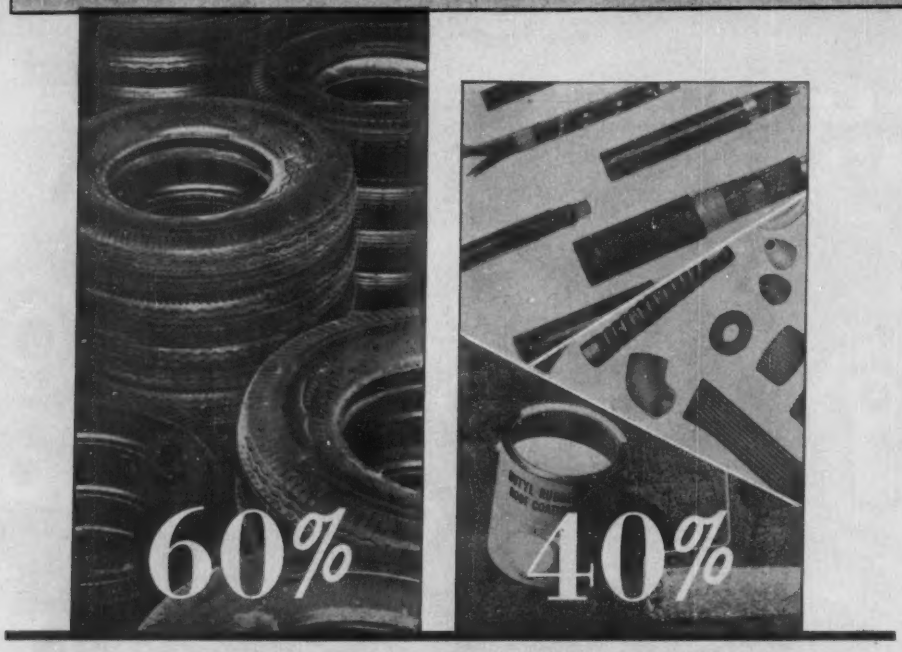

Future Markets Shape Up Along General-Purpose Lines

TIRE: All-butyl tires replace inner tubes as biggest tire factor.

NON-TIRE: Diversified outlets swell via mechanical goods, latex products.

New Market Pattern for Butyl Rubber

Surge in demand, promising to maintain and exceed new high levels, crowns five-year effort to reframe butyl and its markets for new end-product use.

Last year butyl rubber recovered from the mid-Fifties collapse of the inner-tube market enough to reinflate production capacity—and then some.

Output of Humble Oil & Refining and Esso Standard Oil of New Jersey—only butyl producers in the U. S.—rose to 81,000 long tons in '59 from 52,241 in '58. Company has announced plans to boost annual rate to 117,500 in July and to 135,000 in May 1961. Additional expansion plans are under study and capacity will be provided as required by demand.

Last year also brought first commercial production of:

• All-butyl tires: U. S. Rubber and Firestone started making them in the spring for marketing under the Atlas Bucron label. Subsequently, Firestone announced its intent to market under its own name.

• Halogenated butyl: Improving on butyl's ability to resist heat and to blend with other polymers, products will come out of Baton Rouge capacity. They aspire to account for 15% of yearly production before the end of the '60's.

• Butyl latex: Developed initially for cord treatment in

CIGARETTE FIRE DESTROYS BUS
Loss Set At $7,500 In Hackensack Blaze
Hackensack — An Inter-City bus parked at the company's Passaic Street terminal was destroyed last night in a raging fire caused by a lighted cigarette left on a seat of the vehicle.
A spokesman for the company said the $7,500 bus was a total loss.
Engine Company 5 of the Fairmount Station responded to an 8:24 P. M. call, and had the fire under control in 20 minutes.

Photo courtesy Bergen Evening Record, Hackensack, N. J.

Add flame-resistance to your plastics with CELANESE PHOSPHATE PLASTICIZERS

Celanese plasticizers do much more than impart fire-resistant characteristics:—they provide rapid solvation with most resins, assure permanence, are resistant to extraction by oils and water. Celanese gives you four different grades of tricresyl phosphate: low color, low specific gravity, general purpose, and electrical grades. Celanese chlorinated phosphate plasticizers are outstanding for flame retardance. They are often used as additives in thermosetting plastics for their fire-retardant properties alone. For information on Celanese phosphate plasticizers, write to: Celanese Chemical Company, a Division of Celanese Corporation of America, Dept. 553-E, 180 Madison Ave., N. Y. 16. Celanese® Lindol® Celluflex® Celluphos®

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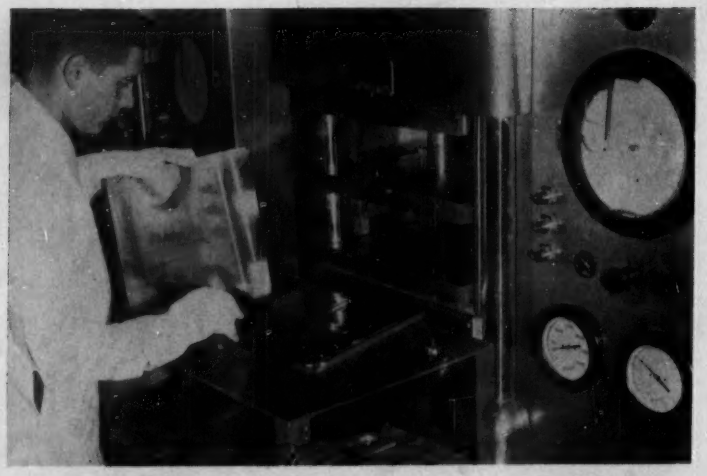
Celanese CHEMICALS



RESEARCH is diversifying butyl use, e.g., giving latex versatility.

building butyl tires, product is now making an independent bid to raise butyl's market sights to include areas beyond those traditionally rubber's.

According to Enjay Co., marketers of Standard of New Jersey's domestic petrochemicals, recent resurgence of demand moved up company's planning calendar for the product at least two years. Momentum came from abroad via two unexpected windfalls: Canadian butyl producer, Canadian Polymer Corp., shut down its 25,000-ton/yr. plant during a three-month strike; France's Societe du Caoutchouc had startup trouble with its 20,000-ton/yr. plant. This gave Esso an interval as world's only producer, raised 1959 exports to 21,000 tons, 60% above the preceding year.

Though the interval is over, demands on the company are holding at new high levels. Enjay believes the real and permanent basis for this bright new outlook is its five-year effort to reframe butyl and its market to suit general-purpose, rather than special-purpose, use. In 1955, the year Jersey Standard took ownership of the government's 90,000-ton butyl capacity, tubeless tires made their debut in original auto equipment. Inner tubes had previously consumed 95% of all butyl.

▶**Non-Tire Use**—But between 1955 and 1957 non-tire uses doubled from 6,000 to 12,000 tons/yr. Consumption in 1958 was something over 15,000 tons; expected in 1960, 23,000. In the automobile itself, number of applications has risen to over 100. Largest single non-tire use is for automotive mechanical goods, next is in wire and cable.

▶**Growth Rate**—A current Enjay advertisement celebrates delivery of the 1-millionth ton of butyl, a total achieved over the 17 years since the product's commercialization. Company foresees the 2-million mark within the next six or seven years.

Tire to non-tire use is expected to shake down to a 60-40 equilibrium. Inner tubes, though they made enough of a comeback to absorb 48,000 tons of butyl last year, are not counted on to contribute heavily to future tire markets. Part of the current demand is due to use of tubes in tubeless tires when they become old or damaged. It could evaporate as recappers gain enough facility in handling tubeless tires to make airtight repairs.

▶**All-Butyl Tires**—The all-butyl tire is the real mainstay of hopes for growth in the tire market. By 1965, company aims to capture 10% of the passenger car market, which today consumes a total of about 512,000 tons/yr. of SBR.

Enjay is working with a number of rubber companies making tires and is hopeful that some may come through this year with a butyl tire. While main interest now is in the passenger car market, butyl is approved by the Army for truck tires.

Although tire costs are difficult to compare because of the many grades and makes, butyl tires are reported to be about 20% more costly than a standard-type synthetic, but still less expensive than the so-called premium types. In return they offer premium properties: They absorb more of the bumps and road shocks; they ride quieter, don't squeal on turns and are unusually resistant to skidding.

Enjay believes recent improvements in conventional synthetic rubber must already be credited to butyl competition: SBR is now being compounded to meet an increasing demand for a softer, quieter ride. It further observes, however, that the improved SBR tires sacrifice some abrasion resistance for the improvement, revert to type after moderate wear.

▶**New Products**—Opening up fresh fields is the development of versatile new types of butyl: halogenated or latex or liquid solution forms. Also, Enjay notes that increasing sophistication of compounding technology has increased uses for which butyl is now accepted.

Specific advances in compounding and processing include: The development of a chemical promotor, Monsanto's Elastopar, to improve and control the resilience level of butyl; entirely new cure agents, such as U. S. Rubber's use of dimethylol phenol resins, to produce a butyl vulcanizate with a higher degree of heat resistance than sulfur or quinoid vulcanizates.

Still under development are ways to produce oil extended butyl and carbon black masterbatch. In the case of styrene-butadiene rubber, these hydrocarbon additives are incorporated during emulsion polymerization, before reaction is complete. Solution polymerization of isobutylene and isoprene to form butyl rubber takes place instantaneously, does not allow time for incorporation of additives by conventional means.

▶**Halogenated Butyl**—B. F.

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The Maxitest has a durable lightweight Alumalife® case with convenient carrying handle. It is also available without handle and back connected for flush mounting. It has an 8½" Maxivision® dial—a two-level dial with needle-sharp pointer on the same plane as the tab graduations to eliminate parallax errors. Case and dial are painted contrasting "eye-rest" greens to assure surest, sharpest readability indoors and outdoors, without eye strain.

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Available in Pressure, Vacuum, and Compound Types—Total graduations range from 0/15 psi to 0/10,000 in pressure types with tab intervals appropriately assigned. 0/30" vacuum type has tabs at 2" intervals. Compound types have graduations 15 psi and 30" vacuum with tab intervals at 3 psi and 5"; 30 psi and 30" vacuum with tab intervals at 5 psi and 10". For testing receiver gauges, the Maxitest can be supplied with dial ranges of 3/15, 3/27 and 6/54 psi.

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Goodrich and Esso have developed brominated butyl and chlorinated butyl, respectively. Both products claim better compatibility with other polymers and faster curing rates. Enjay will soon start commercial distribution of the chlorinated variety. They have been marketing pilot quantities at 35¢/lb.

For brominated butyl, Goodrich claims such advantages over both butyl and chlorinated butyl as better adhesion to other rubbers, fabrics and metals, better tensile strength of blends (*Chem. Eng.*, Feb. 23, 1959, p. 57). Company has been marketing pilot quantities at about 65¢/lb. Though raw material cost will probably keep price high, price could be made more competitive if bromination was incorporated into the flowsheet of a large-scale butyl producer. Industry speculation, therefore, is that brominated butyl might end up as a cooperative effort of Goodrich and Esso.

As for chlorinated butyl, Enjay emphasizes compatibility with other rubbers and ability to withstand heat up to 400 F., a full 100 degrees above the useful limit of previous butyl rubbers. Company expects its price-property combination to make it a strong bidder for such applications as steam hose, liners for tubeless tires. U. S. Rubber's resin-cured butyl also resists 400 F.

▶**Butyl Latex**—One trick that made the butyl tire possible was a butyl latex which permitted the rubber to bond to the tire cord (rayon or nylon). Since butyl itself is made by mass polymerization of isobutylene and isoprene, the latex is made subsequently, by a solvent replacement process which suspends minute particles of butyl gum in water solution.

The physical form of the first butyl latex, about 55% solids, is being marketed for paper coating and saturating, textile treating and proofing, adhesive compounding, leather finishing.

The first latex cannot be coagulated by conventional means, and therefore is not suitable for dipped goods. Films, latex foam and paint are considered logical avenues for commercial exploitation and Esso researchers are hard at developing a chemically sensitive latex.

▶**Liquid Butyl**—A liquid butyl for use as a leakproof coating for roofs is already being marketed. It is not a latex but a prevulcanized liquid form of the polymer. It boasts weather-ability, wearability, ease of use.

▶**Vs. Neoprene & Nitrile**—Despite butyl's resurgence, neoprene is still the second ranking synthetic rubber in volume. However, Kendall Greene of Goodrich-Gulf, speaking before a CMRA meeting last fall, predicted a 7%/yr. growth for butyl through 1965 vs. 2 to 3% for neoprene and 5% for nitrile, which stands below butyl in fourth place.

Butyl is resistant to ozone and corona, chemicals and solvents, animal and vegetable (but not mineral) oils, heat and aging, weather and sunlight, abrasion, cutting and chipping, and tear and flexing. It has excellent electrical properties, colorability and color retention, impermeability to gases. Its low cost—like SBR's a stable 23¢/lb.—has also contributed to its acceptance.

Neoprene's position as an important synthetic elastomer derives primarily from its generally good physical properties, in addition to its good resistance to oil and grease, sunlight, ozone, heat and flame. Neoprene manufacture is expensive, however, precluding significant drops from the current 41¢/lb.

The butadiene-acrylonitrile series of polymers are primarily known for resistance to oil, solvents, heat and abrasion. It commands, however, a premium price of 49¢/lb.

To Make Basic Research Big, Free and Solvent

In a recent speech before the Economic Club of Detroit, Westinghouse President Mark W. Cresap, Jr., summarized latest efforts to overcome obstacles to growth of basic research.

By the new methods, industry finances additional growth. Government provides industry with immediate economic justification, the incentive it must have for large investment.

Advantages over direct grants by government: Money goes straight from taxpayer to laboratory without the attrition and administrative expense resulting from an intermediate stop in Washington. Interference with and control of university research work would be minimized, because the grants would come from many sources. Stability of research operations would be improved, because they would be less subject to annual political review and change.

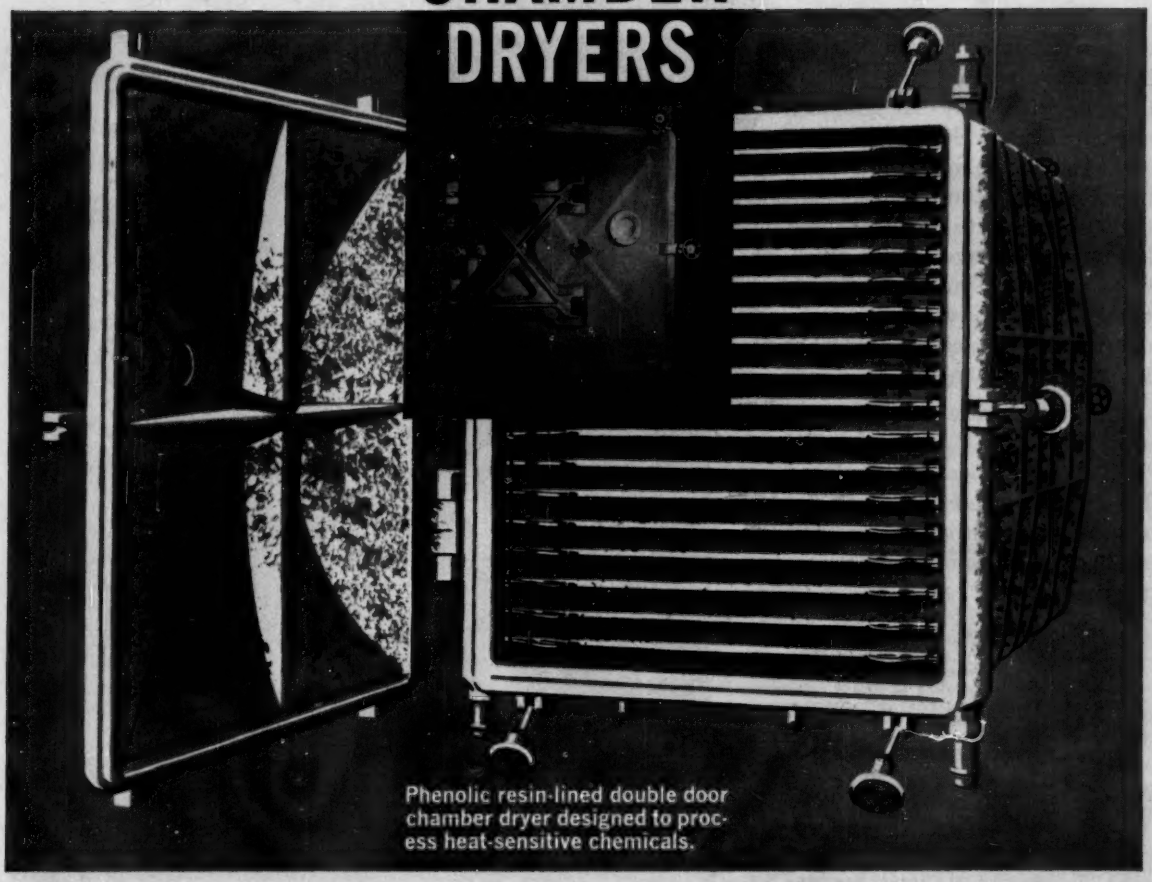
Among the incentives which have been proposed are a faster write-off of new research facilities, an outright tax credit for research contributions or expenditures, and a provision which permits an income tax write-off of more than 100% of expenditures on scientific research facilities, similar to the 120% write-off granted by the United Kingdom.

A bill now before the 86th Congress would amend the 1954 Revenue Code to provide one such incentive. The Curtis Bill HR 4797 would permit a business or individual taxpayer to take an income tax credit—that is, a deduction from the actual tax bill rather than from the taxable income—for contributions to basic research work in science performed by nonprofit research organizations. The deduction would be limited to 90% of the contribution. It could not exceed 5% of the total tax bill. The university or center itself would determine what constitutes basic research, and since they prefer to work in pure science, such grants would have a built-in self-enforcing effect.

Bill would also permit a business taxpayer to take an income tax credit for basic research in science performed in its own laboratories. The credit would be for 75% of the amount spent and could not exceed 3% of the company's total tax bill.

These internal research expenditures would be hedged with safeguards. Research projects would have to be certified by a board of eminent scientists appointed by the President on the recommendation of the National Academy of Sciences. All findings in such projects would be published and so would be, in effect, in the public domain.

DEVINE VACUUM CHAMBER DRYERS



Phenolic resin-lined double door chamber dryer designed to process heat-sensitive chemicals.

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More and more manufacturers are getting to know about vacuum processing, know that it offers special benefits to them. Not as many, however, know that Devine Manufacturing Company was the first to introduce vacuum processing in this country over half a century ago. Ever since, Devine has been solving problems for a constantly growing list of firms and industries with this simple yet most versatile processing tool.

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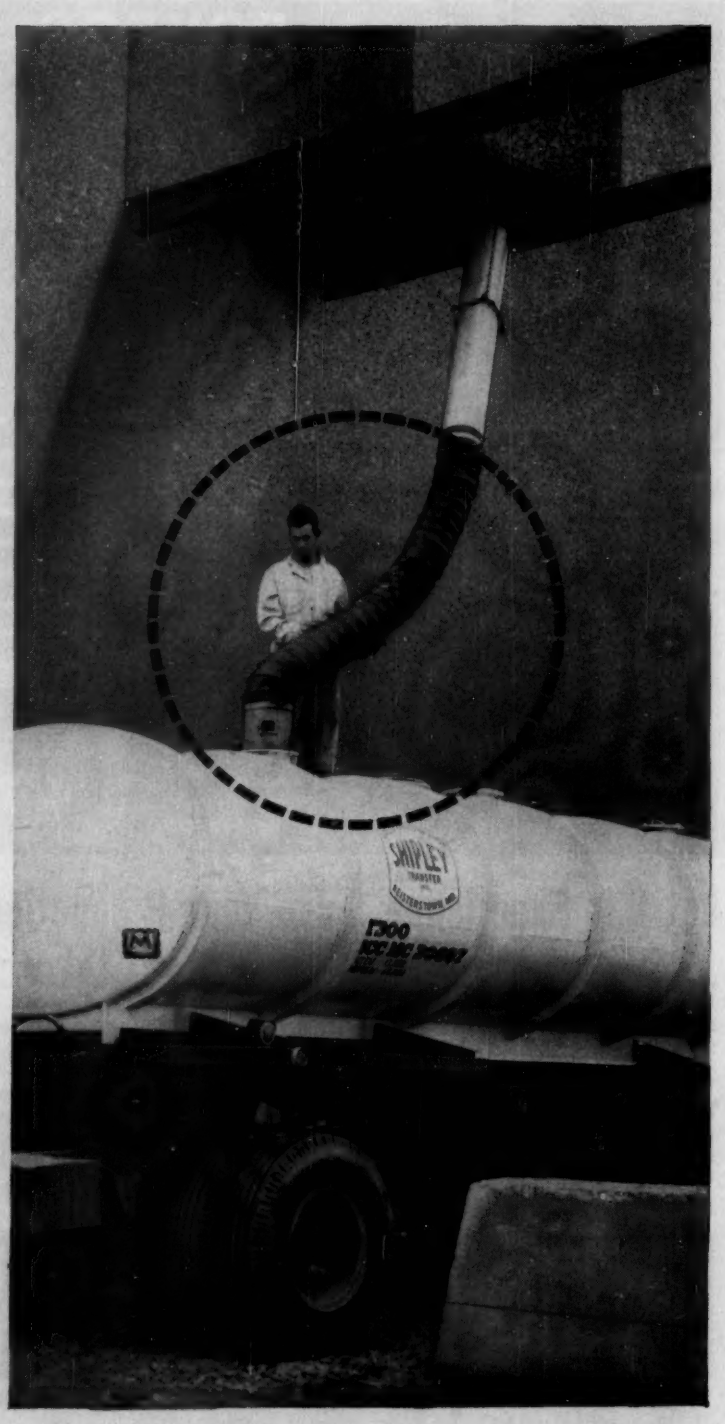


Bis (m-Phenoxyphenyl) Ether

May Head Roster of 1,000-F. Skygoing Fluids

Meta isomer stands out among promising phenoxyphenyl ethers for lubrication, hydraulic uses in tomorrow's burgeoning space technology.

Charles Spar, Fluid Systems Laboratory, Republic Aviation Corp., Farmingdale, N. Y.

Within the past several years a new class of compounds, the polyphenyl ethers, has come into prominence as a likely source for high-temperature fluids in aircraft, missiles and similar applications.

The simplest member of the class, phenyl ether, already has a history of use as a high-temperature heat-exchange fluid. The longer-chain ethers are of more recent interest. Some of them are currently being investigated as part of a development program for a 1,000 F. hydraulic system by Republic Aviation Corp.

Polyphenyl ethers are generally high melting, high boiling compounds, and are limited to use above 20 F. However, this affects only a very few applications requiring high-temperature performance.

Particularly interesting are the compounds having four phenyl groups, namely, the phenoxyphenyl ethers. These can exist in several isomeric forms (as is the case for polyphenyl ethers in general), which have identical properties except for melting point. Considerable data on these fluids have been determined by Shell Development Co.

The meta isomer—bis (*m*-phenoxyphenyl) ether—has received special attention. It not only has a low melting point (104 F.), but it also supercools and remains liquid to a pour point of about 5 F.

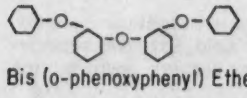
This makes it the only fluid now available with potential for use at 1,000 F. which remains liquid below room temperature.

The material has been subjected to extensive testing under the development program, and has performed successfully at the 1,000 F. level. Although decomposition begins at 830 F., the fluid remains usable for up to 10 hr.

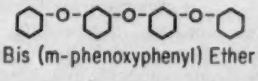
Extremely high purity appears essential, since trace impurities not removed during manufacture have caused crystallization at temperatures above the pour point. On the other hand, a recently produced mixture of isomers has shown excellent stability, with no tendency to solidify even when seeded with crystals.

Both the pure isomer and the mixture are colorless. The mixture becomes slightly amber

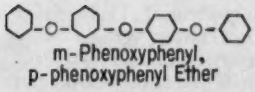
Low-Pour Isomer Highlights Interesting Ether Family



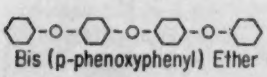
Bis (o-phenoxyphenyl) Ether



Bis (m-phenoxyphenyl) Ether



m-Phenoxyphenyl, p-phenoxyphenyl Ether



Bis (p-phenoxyphenyl) Ether

Mol. wt	354.4
Sp. gravity (68 F.)	1.18
(400 F.)	1.03
Boil. pt. (10 mm. Hg), °F.	540
Sp. ht.*, Btu./(lb.) (°F.)	0.43
Thermal conductivity*, Btu./(hr.) (sq. ft.) (°F./ft.)	0.82
Toxicity	None

* At 300 F.

Editor's Note

Following an over-all picture of the growing field of high-temperature space fluids (CE, Jan. 25, 1960, p. 62), here's a closer look at one promising class of liquids under study, the polyphenyl ethers. In addition to the author's company, Shell Development and Monsanto have also done work with these ethers.

For more news about space fluids see p. 80.

upon exposure to ultraviolet light, but this has shown no effect on over-all stability.

The fluid shows good lubricating ability, not as good as mineral-based oils but better than silicone-base liquids. It also has excellent resistance to nuclear radiation, withstanding up to 10^{11} erg/g. of carbon. This feature becomes increasingly valuable as greater use of nuclear energy is contemplated.

The material exhibits a rather sharp drop in viscosity with temperature rise, resulting in an ASTM viscosity slope of 0.87. However, the absence of a viscosity improver (or any other improver) leads to excellent resistance to breakdown from mechanical working.

In spite of a 465 F. flash point and a 555 F. fire point the substance can be used safely at the 1,000 F. level, since its spontaneous ignition temperature is 1,095 F.

Bis (*m*-phenoxyphenyl) ether resists oxidation and can be used up to at least 600 F. in air if no ignition source is present. Likewise, it shows no reaction with water vapor.

Upon decomposition, above 835 F., the fluid undergoes no significant change in neutralization number (0.2 mg. KOH/g. sample), and only a slight viscosity increase.

A drawback of the fluid is its relatively high vapor pressure. Pressurizing appears important, to minimize evaporation losses.

It has been tested as a bearing lubricant and has performed well; other uses are currently being investigated. Present commercial unavailability is due to the high cost of production, about $500/gal. This applies to pilot plant batches, however, and full scale production could lower the price considerably.

With temperature barriers being continually forced upward, equipment to operate at high temperatures will be more and more in demand. Such equipment will require lubrication, hydraulic power and heat transfer, as well as resistance to nuclear radiation. The polyphenyl ethers show great promise in this field, and are likely to find extensive use in coming years.

Plastic Conduits Muscle In on Wood, Ceramics

An East Coast utility company has found semirigid plastic conduits, made from an ABS polymer named Kralastic, to have many advantages over conduits of wood or ceramic.

The plastic ones are flexible, easily installed, durable and less expensive. Due to their strength, 1-in. plastic conduits can replace 2-in. ceramic.—U. S. Rubber Co., New York. 78A

Epoxy Hardeners

Agents for room-temperature curing give flexible, resilient epoxy products.

Epotuf 2611 and 2613, two new hardeners for curing epoxy resins at room temperature, are now available commercially. It is reported that epoxies which normally yield rigid cured products will yield flexible and resilient ones when treated with these materials.

The 2611 hardener is to be mixed with epoxy in a 1- to 2- ratio. Mixture hardness in under ten minutes, and cures to a blush-free, tough, resilient plastic.

Flexibility is the notable property imparted by the 2613 material. A 1-to-1 mixture with epoxy cures quickly, but with unusually low exotherm, to a blush-free, flexible product which will undergo up to 100% elongation, with total recovery upon stress release.

In plants that have standardized on a single epoxy resin, degree of hardness or flexibility in the cured resin can be directly controlled by blending these two hardeners.—**Reichhold Chemicals, Inc., White Plains, New York. 78B**

Latex

Styrene-butadiene copolymer said to give superior paper coating performance.

A new styrene-butadiene latex for coating pigmented paper and paperboard has received customer acceptance after full scale field trials. It is designated Dow Latex 630.

Reported to provide superior pick resistance and over-all performance, the material promises to be usable with all types of commercial coating equipment

MAXIMUM EFFICIENCY • LONGER SERVICE LIFE
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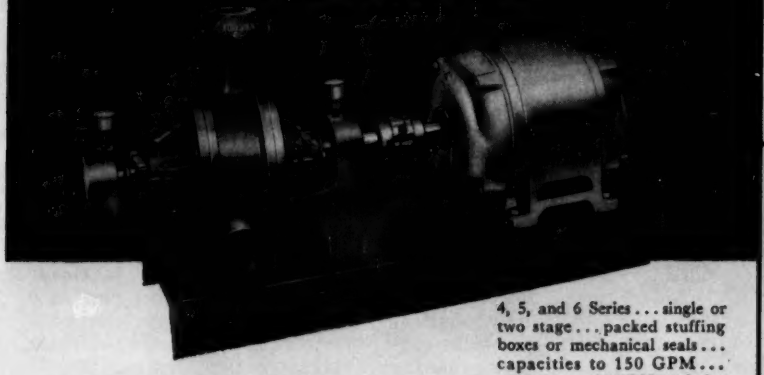
AURORA® APCO TURBINE TYPE PUMPS



4, 5, and 6 Series . . . single or two stage . . . packed stuffing boxes or mechanical seals . . . capacities to 150 GPM . . . pressures to 300 PSI. Ask for Bulletin No. S-111.

★ Long service life . . . with no metal-to-metal contact within the pump channel, wear is minimized.

★ *Easy Maintenance* . . . removal of end covers permits complete disassembly without breaking or disturbing the suction or discharge connections or motor-pump alignment.

★ Complete hydraulic balance . . . achieved with double suction design . . . all hydraulic thrust on outboard bearings is eliminated.

★ Will not vapor bind . . . turbine type impellers handle vapor and air along with the liquid to eliminate vapor lock within the pump.

★ Wide operating range . . . constant capacity is maintained over wide head variations or fluctuating conditions—adjust quickly to changed operating conditions.

★ Ideal for low capacity, high pressure applications . . . boiler feed, condensate return, circulation services, booster services, LPG service, liquid transfer, water treatment, and filter services.

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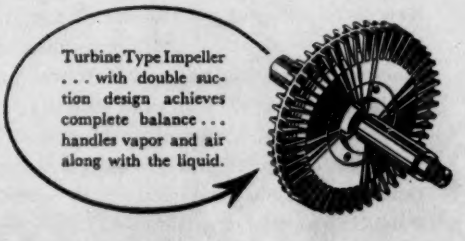
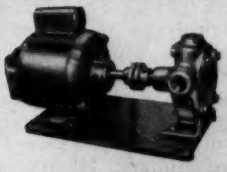


Turbine Type Impeller . . . with double suction design achieves complete balance . . . handles vapor and air along with the liquid.

3 Series . . . Single stage . . . packed stuffing box . . . flexible coupling drive . . . capacities to 12 GPM, heads to 50 feet. Ask for Bulletin U-111-A.

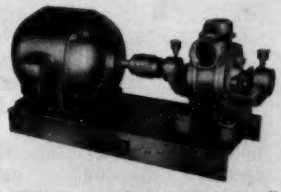


32 Series . . . single stage flexible coupling drive . . . mechanical seal . . . lubricated-for-life bearings . . . capacities to 10 GPM, heads to 250 feet. Ask for Bulletin U-111-B.

Type V31 . . . single stage close coupled . . . mechanical seal . . . self priming . . . capacities to 15 GPM, heads to 350 feet. Ask for Bulletin V-111-A.

Type V4 . . . close coupled . . . single stage . . . mechanical seal . . . capacities to 30 GPM . . . heads to 350 feet. Ask for Bulletin V-111-B.

Type Z4 Chemical Process . . . single stage or two stage . . . mechanical seal . . . capacities to 50 GPM . . . pressures to 400 PSI. Ask for Bulletin Z-111-A.



Type X40 . . . water jacketed packed stuffing boxes or mechanical seals . . . single or two stage . . . capacities to 60 GPM . . . heads to 350 feet. Ask for Bulletin 111XJ.

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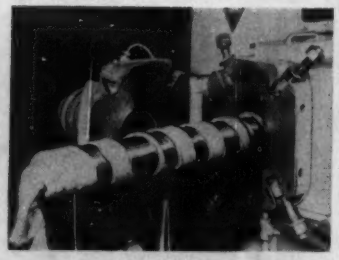
because of its high shear stability.

Protective colloid is not needed with the copolymer, due to its starch compatibility. Its pick-resistance improvement and body stock strengthening properties suggest wide usefulness with all types of printed paper, and it is said to impart a very high degree of printability.

Field experience with the product has shown important economies to be possible in many paper and paperboard coating areas.—Dow Chemical Co., Midland, Mich. 78C



Plastics Remover

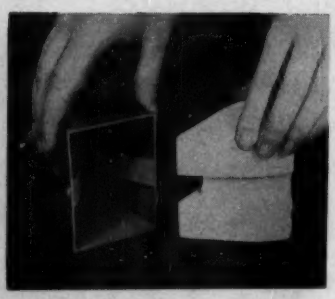
New compound cleans extrusion, injection machines.

A new cleaning compound which is said to remove any thermoplastic material from extrusion or injection molding machines has been developed.

The product has shown in field tests and actual plant practice that it can clean machinery in a fraction of the time required for cleaning by forcing polymer through the machine cylinders. Efficient scrubbing action is attributed to the low melt index of the compound; it also has good heat stability and can be run quickly through the molding equipment.

The cleaner is fed through the feed hopper, after removal of dispersion plates, screen packs, dies or similar auxiliaries. It emerges cleanly from the machinery, and is readily flushed by the plastic or resin to be subsequently molded.

Called A-C Cleaning Compound, the material is used in amounts depending on the equipment size and the degree of contamination.—Allied Chemical Corp., New York. 80A



Ceramic

Foamed insulation for electrical uses over wide temperature range.

The antenna horn cavity above is being fitted with a rigid ceramic material known as Melfoam C-100. It is reported as giving excellent lightweight thermal insulation plus stable electrical properties over a wide range of temperatures.

The foamed dielectric substance exhibits high physical strength, and will operate continuously at temperatures far above the limit for plastic foams. Losses and dielectric constant are said to be low even at levels as high as 1200 F.

Density as well as other properties can be varied to suit specific customer requirements. The ceramic is available in blocks which can be easily machined; custom-sized or custom-formed shapes can also be ordered.—Melpar, Inc., Falls Church, Va. 80B

Jet Lubricants

New fluids have high storage stability, can go to elevated temperatures.

Two developments recently announced in the field of synthetic, high-temperature lubricants have different points of significance. An Esso Research & Engineering fluid shows excellent qualities for storage, and a Heyden Newport product meets military specifications for use in Mach-3 aircraft.

▶ **Petroleum Base**—The former fluid provides a variation on today's synthetic lubricant theme. Properly classified as a synthetic, its raw materials are petroleum substances—refinery olefins—rather than compounds in the chemical (nonpetroleum) category. Part of the manufacturing process consists of reacting the olefins to diesters by the Oxo process.

The lube can be stored under tropical conditions for five years or longer without deterioration. This is believed to be

Newsworthy Chemicals

Page Number is also Reader Service Code Number

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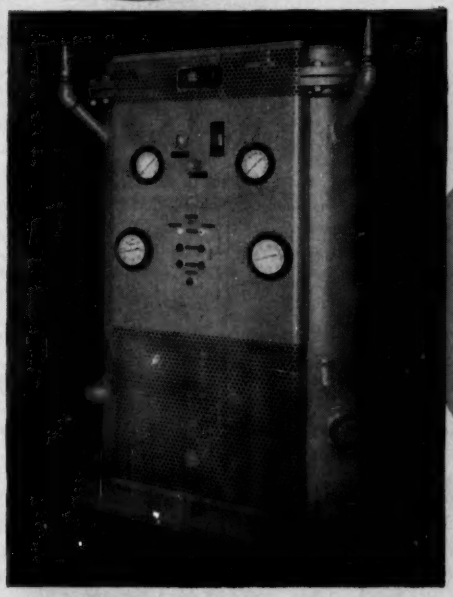

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No Injections With New Synthetic Penicillin

The scientists examining a synthetic penicillin molecule model above, Drs. H. T. Huang (left) and T. A. Seto, are jointly responsible for development of an improved, "tailor-made" oral penicillin named Maxipen.

The synthetic drug is said to produce blood serum levels about twice as high as oral penicillin V and its potassium salt, and higher than injectible procaine penicillin G. High level is due to product's stability in stomach acid and to its solubility.

Maxipen is a mixture of the D and L isomers of alpha-phenoxyethyl penicillin potassium. More than 50 medical investigators have been studying the effectiveness of the drug in clinical practice.—J. B. Roerig & Co., Div. of Chas. Pfizer & Co., Inc., New York. 82B

the best storage stability yet offered in the jet oil field. The material is being supplied to the military in large quantities. **—Esso Research & Engineering Co., Linden, N. J. 80C**

▶ **425-Plus**—The Heyden Newport lubricant, designated Pentalube TP-653-B, has qualified under a newly-issued Air Force specification covering requirements for use with Mach-3 aircraft. This follows 18 months of testing as an across-the-board fluid for service at 425 F. or higher.

The material can also operate at low temperatures around —65 F. Test performance indicates that its use may lead to reductions in required engine maintenance, as well as less frequent oil changes.

Raw materials (not disclosed) for the lube are said to be available in very large quantities. The recent qualification permits production-scale procurement of the fluid.—**Heyden Newport Chemical Corp., New York. 82A**

BRIEFS

Radioactivity-combating detergents are currently in use in atomic research laboratories, to remove contamination from such materials as textiles, plastics, paints, rubber and metals. One compound is said to be able to deal with contamination even after it has become chemically bound to working surfaces or to clothing. Its use also prevents readsorption of the contaminant during dilution and rinsing. **—U. K. Atomic Energy Authority, London. 82C**

Antiseptic polyethylene, said to be particularly effective as a killer of disease-producing staph organisms, has been developed. Trademarked Surfaseptic, the material is intended for applications such as toys, wastebaskets, door knobs, portions of telephone headsets, arm rests on public conveyances, and similar articles where health protection is desirable. Tests with toys show that the material combats bacteria during the normal life of a toy.—**Dow Chemical Co., Midland, Mich. 82D**

Coal tar is a component in new, chemically cured protective coatings named Bitumastic No. 100 and Bitumastic No. 300. Former is said to resist corrosive atmospheres, undercutting and petroleum solvents, and to be safe for drinking water storage and handling; latter is described as an extra-heavy-duty, tough coating with high resistance to abrasion and chemical environment. — **Koppers Co., Pittsburgh, Pa. 82E**

A fluorine-containing elastomer, Viton (Du Pont trademark) is available in various colored and black solutions. This will permit use as insulation or coating when molding is not desirable or physically possible. — **Pelmor Laboratories, Newtown, Pa. 82F**

For More Information

about any item in this department, circle its code number on the

Reader Service

postcard (p. 181)

Engineering Progress Report

FROM UNION CARBIDE CHEMICALS COMPANY

Acetonitrile boosts butylene throughput 58%, saves $3,000,000 capital investment

Unusual solvent useful in saturate-unsaturate and olefin-diolefin separations

By using acetonitrile as an extractive distillation solvent, Shell Chemical Corporation has boosted throughput of the existing butadiene feed-preparation unit 58% in their Torrance plant. Minor engineering changes for the unit cost $148,000: it has been estimated that a similar throughput increase through new construction would cost about $3,000,000. Development work and operating experience have shown that acetonitrile's unusual solvent properties should prove useful in other saturate-unsaturate and olefin-diolefin separation processes.

ADVANTAGES OF ACETONITRILE

Acetonitrile has boosted capacity in the Shell plant because it increases the spread in boiling points of the C_4 hydrocarbons being distilled. Thus, separation of the hydrocarbons is more efficient than with either acetone or furfural. Relative volatility of n-butane compared to butene-1 is about 1.25 with acetone and about 1.30 with furfural. Acetonitrile increases this ratio to almost 1.4. The spread in boiling points of butene-1 and butadiene is also increased. The table gives data on the relative volatilities of C_4 hydrocarbons in aqueous acetonitrile systems.

After the extractive distillation has been completed, acetonitrile can be completely recovered from the butane and butylene streams with greater ease than acetone. This increased recovery efficiency is due to the high distribution coefficient of acetonitrile in water/hydrocarbon systems.

ENGINEERING CHANGES MINOR

Because of the similarity of the physical properties of acetonitrile and acetone, it is not necessary to change the operating pressure of extractive distillation columns. Shell engineers made only minor changes to their unit. Besides a larger reboiler and a new pump, two heat exchangers were switched and the solvent recovery column was connected to vacuum operation. Aqueous acetonitrile systems do not foul exchanger systems. Corrosion due to hydrolysis of solvent at reboiler temperatures is minimized by pH control.

TABLE 1 RELATIVE VOLATILITIES OF THE C_4 HYDROCARBONS IN AQUEOUS ACETONITRILE, 120 psia

Component	Total Solvent Concentration, 80%m		Total Solvent Concentration, 85%m	
	Water in Solvent 15%m	Water in Solvent 25%m	Water in Solvent 15%m	Water in Solvent 25%m
Isobutane	1.638	1.673	1.637	1.674
n-Butane	1.332	1.347	1.348	1.368
Isobutylene	1.013	1.013	1.013	1.013
Butene-1	**1.000**	**1.000**	**1.000**	**1.000**
t-Butene-2	0.861	0.856	0.865	0.861
cis-Butene-2	0.821	0.813	0.827	0.820
Butadiene-1, 3	0.639	0.599	0.645	0.604
Water	0.08	0.045	0.075	0.045
Acetonitrile	0.043	0.033	0.043	0.033

OPERATING COST REDUCTIONS

The butadiene feed-preparation unit operating on acetonitrile has less solvent-loss than one operating on acetone. *Thus, solvent make-up costs are no higher with acetonitrile than with acetone.* Steam and pumping costs have also been reduced because reflux and circulation rates are lower. This is true even at reduced feed rates.

ACETONITRILE USEFUL IN OTHER PROCESSES

Acetonitrile is effective in other saturate-unsaturate and olefin-diolefin separations. This heat-stable extractant is useful in ethylene-ethane, propylene-propane, and cyclopentadiene-cyclopentane separations. The boiling point spreads between pentadienes, such as isoprene, and pentenes are also increased.

In liquid-liquid extraction processes, acetonitrile is effective in removing tars, phenols, and color bodies from hydrocarbons. Acetonitrile is also useful as a selective solvent for fatty acids.

INFORMATION AVAILABLE

If you're looking for increased efficiency in your extractive distillation or liquid-liquid extraction processes, acetonitrile could be the answer. Detailed information on acetonitrile as an extractive distillation solvent along with information on azeotropic mixtures of acetonitrile is available. For this information, call the nearest CARBIDE Technical Representative—or write, Department B, Union Carbide Chemicals Company, 30 East 42nd Street, New York 17, New York.

Nothing herein shall constitute a recommendation to practice any invention covered by any patent without permission of the patent owner.

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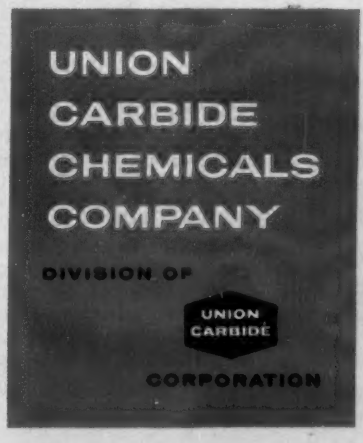
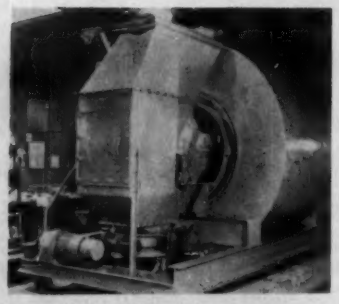


DEVELOPMENTS . . .

PROCESS EQUIPMENT

EDITED BY C. S. CRONAN



Blender-Hopper

Unit adapts quickly to existing plants.

Sturtevant's new, wholly-automatic, multipurpose blender and hopper, on a movable bed, is claimed to provide a near-perfect processing bridge; it blends materials as they come directly from other processes, introducing them directly into the next. A supplemental chamber holds other ingredients to be introduced into the next process, yet keeps them from intermixture with the blending materials until the appointed time.

Offered with capacities from 500 lb. to 20 tons, the units are dust-tight at all points and keep their dust seals during filling or discharge. A single control panel regulates the entire process.—**Sturtevant Mill Co., Boston, Mass.** 84A

Two-Way Valves

Aspirator system enables instantaneous flow cutoff.

New in design, a series of lightweight corrosion-resistant flow control and shutoff valves incorporates aspirator systems in the bypass ports to create immediate negative pressures on the full-flow downstream port when valves are actuated to the bypass position. This "suck-back" feature immediately reduces downstream line pressure and permits instantaneous cutoff of liquid flow.

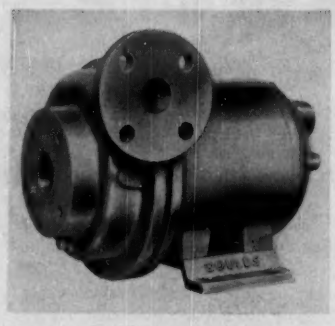
Each valve is simply designed with assembly and disassembly of internal parts accomplished without removal of valve from piping system. The units come with pipe thread, hose fittings or tubing connections in 1- and 2-in. sizes.—**Agricultural Aviation Engineering Co., Santa Clara, Cal.** 84B

Rescue Breather

Low-cost device has many emergency functions.

Selling for less than $200 with standard oxygen cylinder, the new Samaritan rescue breather may be used as a demand inhalator, an aspirator, or a resuscitator suitable for application with or without oxygen. When used as an oxygen resuscitator, the unit is not dependent on compressed oxygen as a source of power for operation of the mechanical valve.

After the oxygen cylinder is depleted, and if a spare is not available, the Samaritan may be used as a mouth-to-mask resuscitator. After a patient has been revived, he can continue to receive oxygen at the rate he "demands". The device will also remove fluids from a victim's mouth and upper throat. When fully charged, the Samaritan weighs only 26 lb.—**Globe Industries, Dayton, Ohio.** 84C



Canned Pump

Centrifugal unit pumps up to 110 gpm. clear liquid.

Having no mechanical seal, stuffing box or gland, Goulds Pumps' new canned centrifugal pump is claimed to be positively leakproof. Designed for handling of volatile, toxic, inflammable or other hazardous liquids, the pumps come in two sizes with capacity ranges to 110 gpm. and heads to 100 ft. Discharge lines are 1 and 1¼ in. Standard material of construction is Type 316 stainless steel.

Cooling of the motor and lubrication of all parts is accomplished by circulation of a controlled portion of the liquid being handled. All units come equipped with a built-in thermo cutout device.—**Goulds Pumps, Inc., Seneca Falls, N. Y.** 84D

Microfilmer

High-speed unit reproduces detailed drawings.

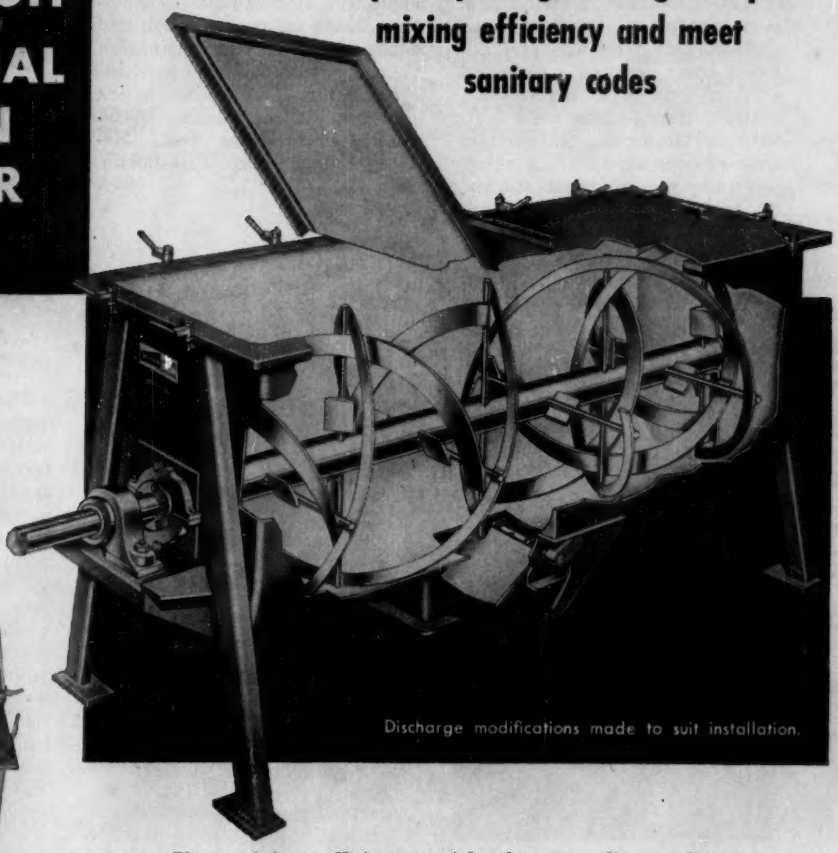
Continuously feeding engineering drawings from a pile, a new high-speed microfilming machine registers original sheets, conveys them under the camera, adjusts illumination to the proper level, photographs the drawings, and discharges them to a delivery pile.

Sheets up to 22 x 34 in. can be

NEW...

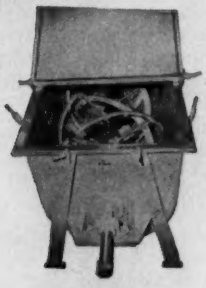
STRONG-SCOTT INDUSTRIAL RIBBON BLENDER

Specially designed to give top mixing efficiency and meet sanitary codes



Discharge modifications made to suit installation.

Rounded tub ends prevent material hang-up, neoprene cover-seals provide dust-tight fitting.



- Swing or slide-type discharge gate, curved to eliminate dead pocket.
- Unique coupling permits vertical removal of agitator assembly without disturbing shaft ends and bearings.
- Heavy-duty, outboard anti-friction bearings.
- Air-purge, lip seal or stuffing box seals readily removed for quick cleaning.
- Dust-tight covers, with quick-action clamps.

Top mixing efficiency with the new Strong-Scott Ribbon Blender mixer on dry or semi-dry materials, has been proven through continuous testing. The Ribbon Blender also meets requirements of health codes where necessary.

The ability to thoroughly and quickly mix is provided by a unique "ribbon assembly." The smallest amount of additives are thoroughly mixed in a matter of minutes. Special smooth-surface, cornerless welding and rounded corners throughout, leave no place for material to gather. The cover is seal-tight for maximum cleanliness and dust control.

Nine different size units ranging from 16 to 300 cubic feet working capacity are available in stainless steel or carbon steel. Jackets for heat transfer mediums also available.

EQUIPMENT DESIGNED FOR BETTER PROCESSING

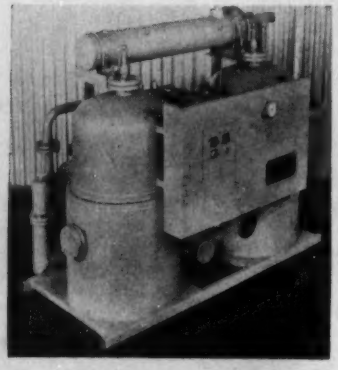
The Strong Scott Mfg. Co.

451 Taft Street N. E., Minneapolis 13, Minnesota

handled, as well as roll drawings up to 42 in. wide. Speed of operation is 1,200 drawings/hr.

In operation, vacuum cups pick up the drawings and advance them through a series of grip rollers to a registration station. Here, photo cells activate electro mechanical devices that square an adjustor sheet.

At the photographic station, an exposure-control photo cell scans each drawing and adjusts illumination to produce a uniform background density. After filming, other mechanical devices advance the sheet to the delivery pile. Resolution equals 130 lines/min.—**deFlorez Co., Englewood Cliffs, N. J.** 84E

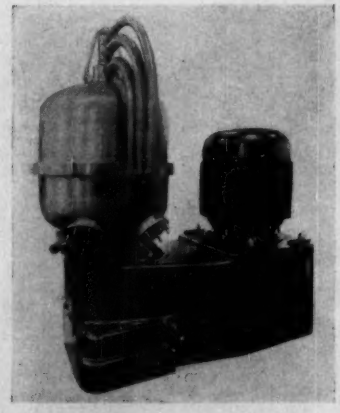


Gas Dryer

Automatic machine drys plant instrument air.

Designated type BZ, a new line of drying equipment for compressed air or other gases features simplicity and modern, functional design. Planned particularly for instrument-air service, the unit has parts that are interchangeable and easily accessible, simplifying maintenance.

Operation is completely automatic. Working on a 6-hr. cycle, the system adsorbs moisture, heats for regeneration and cools with little more attention than occasional lubrication. Instrumentation permits quick checking at a glance.—**Pittsburgh Lectrodryer Div., McGraw-Edison Co., Pittsburgh, Pa.** 86A



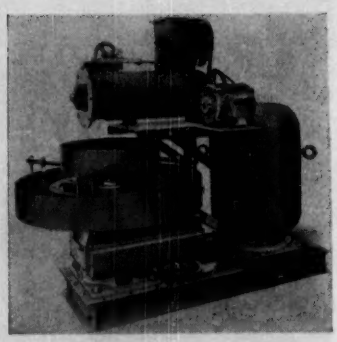
Centrifuge

Designed for continuous high-pressure service.

Solids concentration, liquid clarification or solid-particle classification are among the possible applications for the new QX-312 nozzle-bowl centrifuge. Capable of high-pressure and high-temperature operation, the unit can handle up to 450 gpm. at temperatures to 300 F. and system pressures to 125 psi.

Top cover connections serve for feed entry, effluent discharge and recirculation, if required. Bottom connections are for nozzle discharge and vent for the nozzle discharge. Solids discharged from the nozzle flow by gravity from the vented sludge port.

Both top and bottom pressure covers are made of stainless steel. For quick opening and closing, the covers are sealed together with a single coupling ring. It is unnecessary to disconnect permanent plant piping for removal of the cover.—**DeLaval Separator Co., Industrial Div., Poughkeepsie, N. Y.** 86B

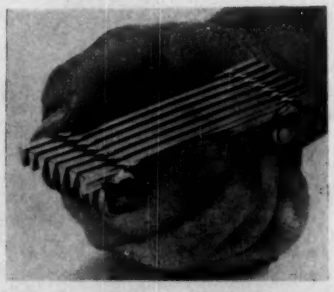


Pellet Mill

All-new line for granular and fibrous material.

Powered to match production demands, a new line of precision pelleting machines is offered for densifying and extruding dry and low-moisture powdered, granular and fibrous material. Design permits maximum production/power ratio for producing pellets up to 2 in. long, and ¼ to 1 in. dia.

Claimed features include: horizontal head with stationary pelleting dies; low rpm. for less wear; easily adjustable cutters for accurate length control.—**Industrial Div., Daffin Mfg. Co., Lancaster, Pa.** 86C



Wedge-Wire Screen

Self-cleaning screen can pass more tons per hour.

Made with wires of thinner profiles than previously available, a new wedge-wire screen

For More Information about any item in this department, circle its code number on the **Reader Service** postcard (p. 181)

EQUIPMENT NEWS Continues on . . . **Page 166**

Introducing—

D-500 Fire Hose

—for a surer kind of protection under fire

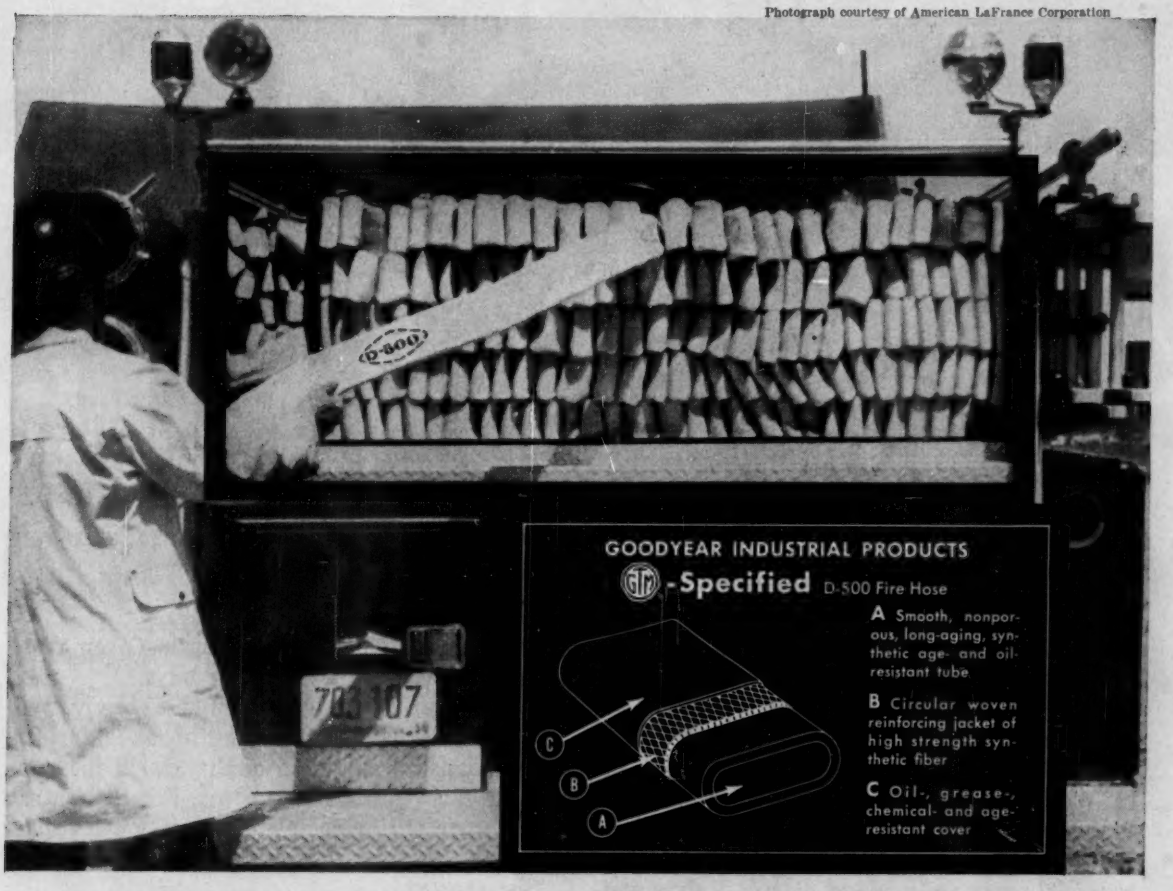
Here's hose with all the dependable durability a 500-lb. factory test assures-plus lighter-weight construction that makes for easy handling. It's highly flexible and *stays* that way. And it's mildewproof.

Petro-chemical users will cash in on its unsurpassed oil- and chemical-resistance – inside and out. In fact, that's important to any user of the newest fire-fighting chemicals. And D-500 Fire Hose is available with white, black, yellow or red cover for ready visibility as well as for those who require color-coded fire-fighting lines.

What's more D-500 Fire Hose is guaranteed throughout its long life against defects in workmanship and materials. For the full story of this newest advance in fire-fighting equipment, contact the G.T.M. through your Goodyear Distributor–or by writing Goodyear, Industrial Products Division, Akron 16, Ohio.

IT'S SMART TO DO BUSINESS *with your Goodyear Distributor. He can give you fast, dependable service on Hose, V-Belts, Flat Belts and many other industrial rubber and nonrubber supplies. Look for him in the Yellow Pages under "Rubber Goods" or "Rubber Products."*

Photograph courtesy of American LaFrance Corporation

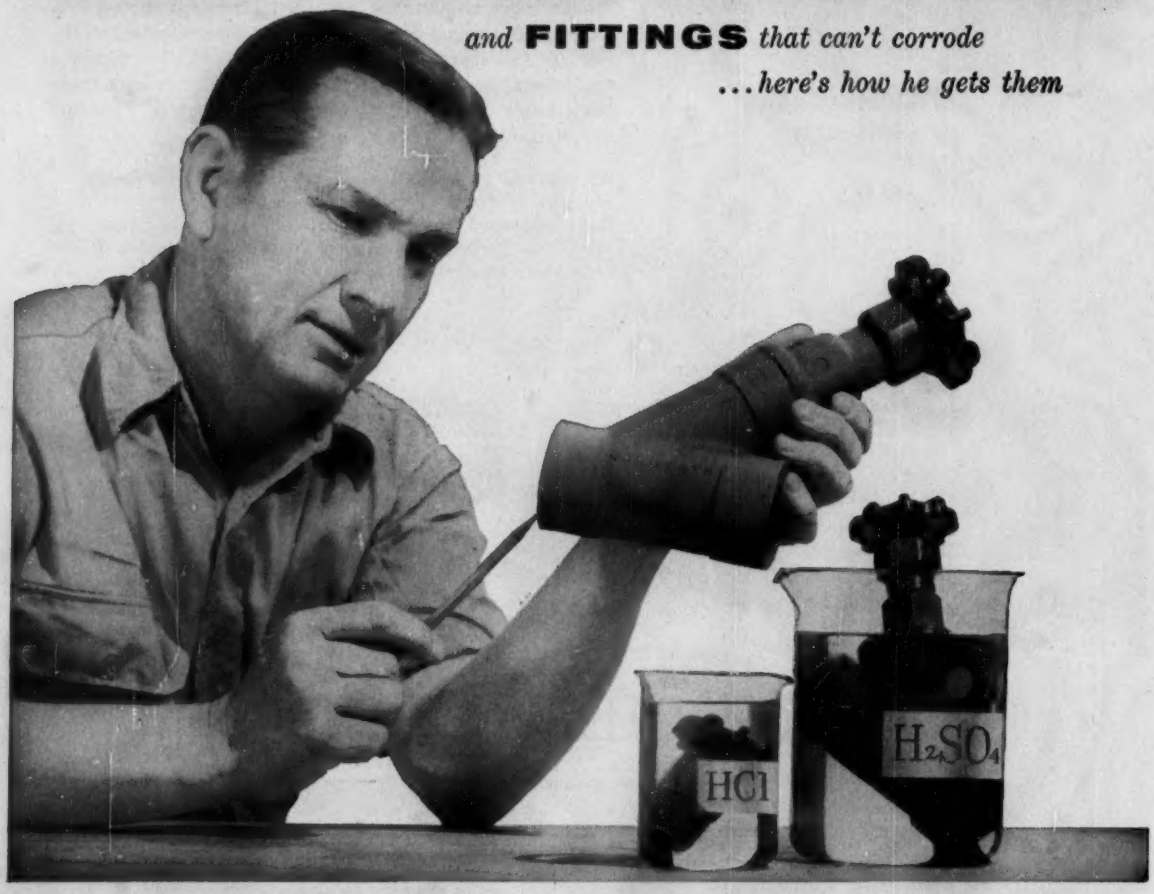

GOODYEAR INDUSTRIAL PRODUCTS
GTM-Specified D-500 Fire Hose
A Smooth, nonporous, long-aging, synthetic age- and oil-resistant tube
B Circular woven reinforcing jacket of high strength synthetic fiber
C Oil-, grease-, chemical- and age-resistant cover
C
B
A

INDUSTRIAL FIRE HOSE BY

GOODYEAR

THE GREATEST NAME IN RUBBER

the WALWORTH CUSTOMER *wants* PLASTIC VALVES *and* FITTINGS *that can't corrode ...here's how he gets them*



When the Walworth Customer is faced with the control of corrosive fluids, he looks at dozens of plastic valves and checks them for himself. He demands answers to questions like these: Can this valve corrode? Is it toxic? Is it non-aging? In Walworth PVC Valves and Fittings, the Walworth Customer finds his answers. Not only is PVC nontoxic and non-aging, – it *can't* corrode. *All* parts are made of plastic. Valves and fittings have high burst strength. Given those facts the Walworth Customer buys.

That may be the way you like to buy valves, too. If you insist on knowing about materials, workmanship and high quality, we'd like you for a Walworth Customer, too. For the newest literature on the complete line of PVC Valves and Fittings, get in touch with your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

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Low cost, excellent resistance to corrosion:

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sheet, pipe, fittings, linings

Federated lead products are self-healing; malleable, easy to form and bend; salvable with high scrap value; and probably the most efficient protection you can find for many corrosive chemical conditions. These products include chemical lead sheets to your requirements; pipe, bends, traps and standard fittings available from stock; special forms fabricated to order. Write for Bulletin No. 162, the Lead Handbook for the Chemical Process Industries, to Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, RE 2-9500; or call your nearest Federated sales office.

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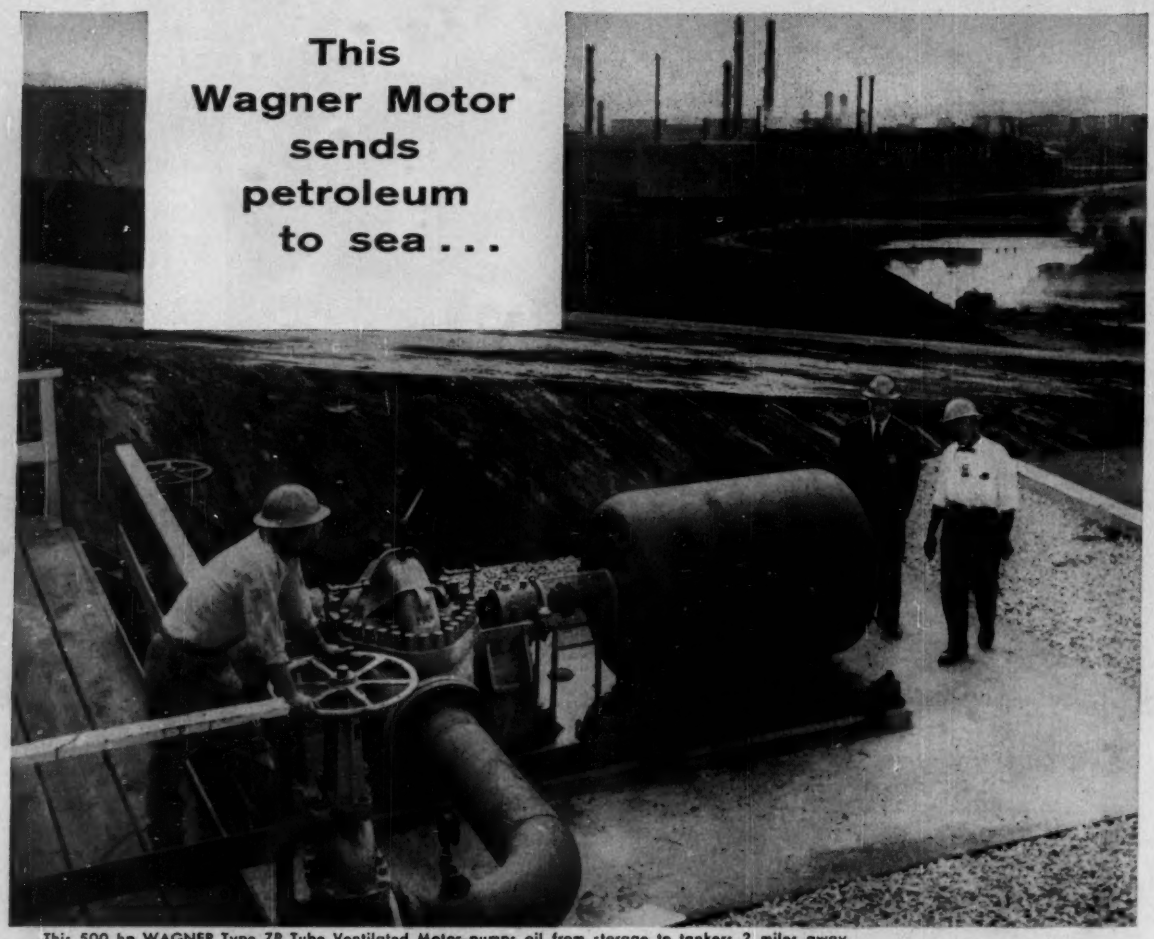
This Wagner Motor sends petroleum to sea . . .



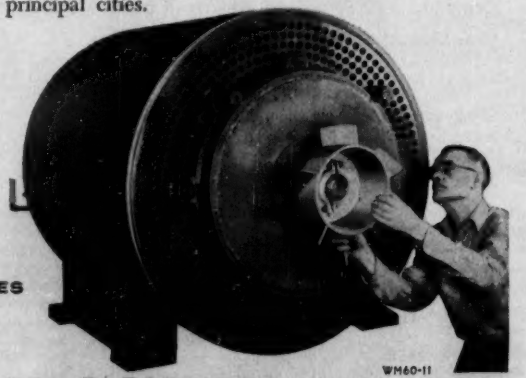
This 500 hp WAGNER Type ZP Tube Ventilated Motor pumps oil from storage to tankers 2 miles away.

Big job, moving petroleum products to market. Standard Oil of California does it well . . . helped, at its El Segundo Refinery, by this 500 horsepower Wagner Tube Ventilated Motor. This explosion-proof motor's job: provide the power to pump crude oil from storage tanks down to the sea—and waiting tankers—two miles away.

Starting oil on a bon voyage is just one of many heavy-duty jobs performed by Wagner Tube Ventilated Motors. They also power big fans, blowers . . . any heavy-duty application that must be operated for long periods of time without a shut down.

These motors have fabricated steel frames that contain a series of tubes (as shown in photo below) through which cooling air is forced by an external blower. Internal blowers, one at each end of the rotor, circulate the warm air inside the motor through ducts in the rotor and stator and around cooling tubes. This effective cooling system holds the operating temperature of the motor within specified limits to lengthen motor life.

Whatever your motor requirements—large or small, for plant or product—Wagner can supply a standard motor or build a special motor to fit your needs. More than 65 years of constant research and development in electric motor design have made Wagner a name you can depend on. Call your nearby Wagner Sales Engineer for an analysis of your next motor application. There are Wagner branches in 32 principal cities.



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Wagner Electric Corporation

6407 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

WM60-11

SERVING 2 GREAT GROWTH INDUSTRIES—*ELECTRICAL • AUTOMOTIVE*

ECO ENGINEERING NEWS
the big name in small pumps for the process industries

Pumping Problems Solved with Eco

(Names of users, where not mentioned, will be supplied on request)

Methanesulfonyl Chloride:

Highly reactive, methanesulfonyl chloride is being pumped continuously, from 8 hours to 24 hours per day with complete satisfaction by Eco GEARCHEM Pumps made of zirconium and du Pont Teflon. Leakage of this lachrymatory liquid is positively controlled.

This installation replaced another make pump which cost over $1000.00 and which required another $1000.00 per year to keep in repair.

Lacquer Ink Services:

Reynolds Metals Company have used Eco BRONZECHEM Pumps for lacquer ink services for the past five years and continue to order.

These bronze body pumps with Teflon Impellers, bearings and packing are of rotary, positive displacement design providing linear, *non-foaming* flow ideal for this service. They are periodically flushed to prevent hardened lacquer film build-up within the pump during shutdown cycles.

Mercury:

Mercury is a problem fluid to pump. It is bone dry—having no lubricating qualities at all. It is 14 times heavier than water. And it is a fugitive element extremely hard to contain in any conventionally packed stuffing box.

The exclusive capabilities of Eco GEARCHEM Pumps to handle this medium with flows in the gallon range and providing accurate metering to the requirements of the chemical, electronic, instrument and other industries, have been responsible for many recent installations.

These Eco pumps in service have a maximum rate of 5 gpm at 100 psi with flooded suction. Some are being driven by 1200 rpm direct connected motors and others are belt driven. After several months, without need for service, the Eco lantern ring stuffing box with Teflon packing and special sealing grease, still provides positive leakless operation.

302°F Sulphuric Acid:

Because of the increased corrosive effect of sulphuric acid at advanced temperatures, an Eco GEARCHEM Pump made of Hastelloy* C with Hastelloy C shafts and gears, ceramic wear plates, carbon sleeve bearings and Teflon packing was selected for this service.

Eco's wide choice of metals from the stainless steels to zirconium and titanium provides the answer to all corrosives, concentrations and temperatures.

(continued on next page)

*Union Carbide Trademark.

Pumping Acid Solutions of Rare Earths in Ion Exchange Installations

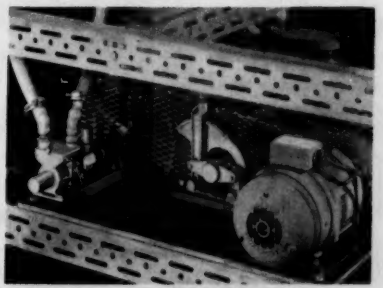
At Lindsay Chemical Division of American Potash & Chemical Corp., Eco CENTRI-CHEM Centrifugal Pumps are literally supplying "Taxi Service" for acid solutions of Rare Earths and sequestering agents.

Mounted on castered dollies, as illustrated above, and coupled to hoses or flexible pipes, these compact pumps are moved from system to system as the cycle of operation progresses, supplying the flexibility needed for solution transfer in these ion exchange installations. In some cases, it is not unusual to have pumps operate continuously for twenty-four hours or longer.

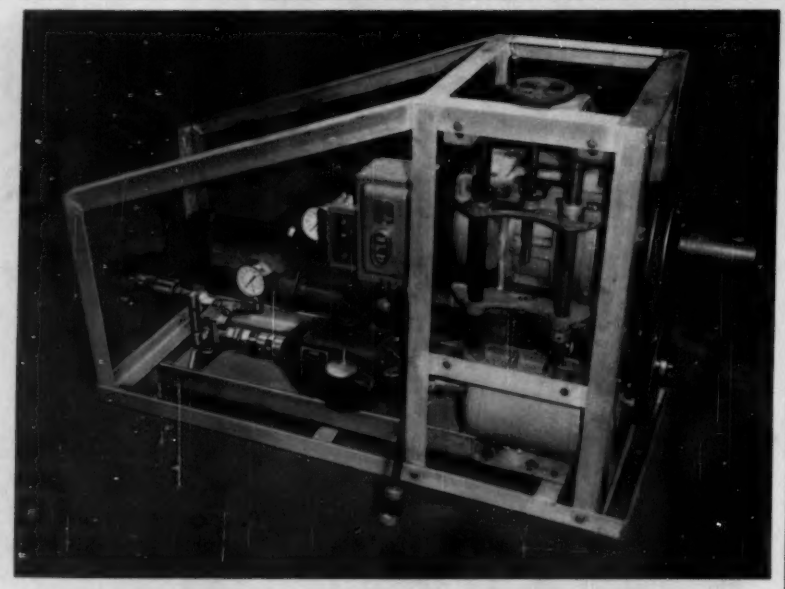
The CENTRI-CHEM Pumps of Carpenter 20 stainless steel are standard-equipped with Eco mechanical seals of Teflon-ceramic design. They have proved dependable and have occasioned very little down time over a period of more than 4 years.

Also at Lindsay are Eco ALL-CHEM positive displacement rotary pumps equipped with fluid Teflon seals. These pumps, utilized in solvent extraction, transfer acid solutions of Rare Earths and organic solvents over a wide delivery range from 0.1 to 20 gpm. These pumps are coupled to variable speed drives for varying delivery rates.

These Eco ALL-CHEM Pumps also have proved dependable for this service.



Eco ALL-CHEM Pump, with variable speed drive, serving solvent extraction installation at Lindsay Chemical Div., American Potash and Chemical Corp.



Triggering "Gel" of Chemical Grout in Soil Stabilization

Thomas Adair Contracting Corporation, Edison, New Jersey, manufactures equipment for injecting chemical grout to solidify weak, granular soils during tunneling and construction excavating, as well as to seal off flows of underground water into oil wells, drill holes, basements, tunnels, mine shafts, coffer dams, sewer pipe joints, caissons, etc. Of special interest is its use to seal underground curtain walls in and around dams or dikes.

The equipment comprises two positive displacement pumps—one for handling the water-thin chemical grout, which easily penetrates the soil to be stabilized, and the other, an Eco GEARCHEM Pump with Vickers variable speed drive which permits accurate proportioning of the amount of ammonium persulphate catalyst, introduced at the point of injection, to vary the gel time required, which may range from a few seconds to several hours.

Close up of Eco GEARCHEM Pump metering catalyst in chemical grout injection system.

This equipment, now generally available to the construction contracting industry, was designed by engineers who pioneered chemical grouting and have had many years of experience in its application on all types of soil stabilization problems from coast to coast.

Their selection of Eco GEARCHEM Pumps in 316 stainless steel with Teflon gears, bearings and packing as standard equipment for these units was made after careful investigation of all small chemical pumps available for the purpose.

The GEARCHEM Pump's positive corrosion resistance; its unmatched dependability, day in and day out in hard service in the field; its accurate metering ability; and the fact that it is a standard stock pump, easily and quickly available anywhere and with complete interchangeability of precision parts for field maintenance, offered outstanding advantages which no other small chemical pump could provide.

ECO Products for Handling Corrosive and Hazardous Processing Fluids

ALL-CHEM® Rotary Pumps
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Pumping Problems *(continued)*

Methylene Chloride:

Dow Chemical keeps reordering Eco CENTRI-CHEM Carpenter 20 stainless steel pumps for methylene chloride service.

Since this is a nasty solvent, leakage of which would not only be objectionable but hazardous as well, it is undoubtedly the superior dependability of Eco's Teflon-Ceramic mechanical seal which has influenced Dow to pass over all the other centrifugal pumps on the market today and continue to specify the Eco CENTRI-CHEM for methylene chloride.

Nitric Acid Transfer:

Eco CENTRI-CHEM Carpenter 20 stainless steel pumps are used by Wyandotte Chemicals Corp.

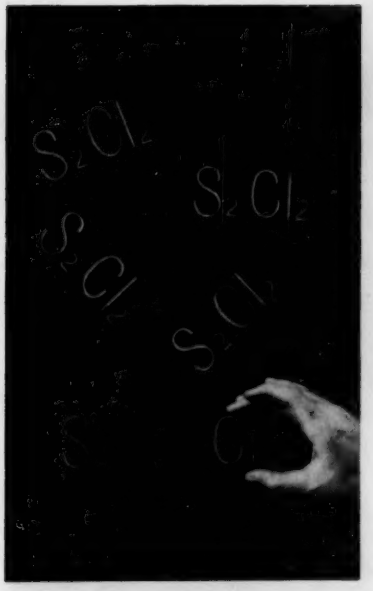
Sorbitol: (Reg. T.M. Atlas Powder Company) with viscosity of 750 SSU at 100°F is pumped at 50 psi with Eco GEARCHEM Pump in 316 stainless steel construction.

Monochloracetic Acid: an exceedingly hazardous material, is pumped with an Eco GEARCHEM in Hastelloy C, with Teflon components and floating wear plates.

Special Detergent: a compound of dodecylbenzene sulfonic acid, sulphuric acid, sodium hydroxide, lauryl diethanolamine, nonylphenol 12-ethylene oxide, hexylene glycol, isopropanol and odorant with water —is pumped with Eco GEARCHEM Pump of Carpenter 20 stainless steel with Hastelloy gears. Temperature of media is about 100°F with viscosities to 3000 SSU.

BRIEFS

on a low-cost chlorinating agent
purity-protected carbonate of potash
fast-dissolving sodium benzoate



S_2Cl_2 . . . EASY WAY TO GET CHLORINE

Hooker sulfur monochloride is a good chlorinating agent.

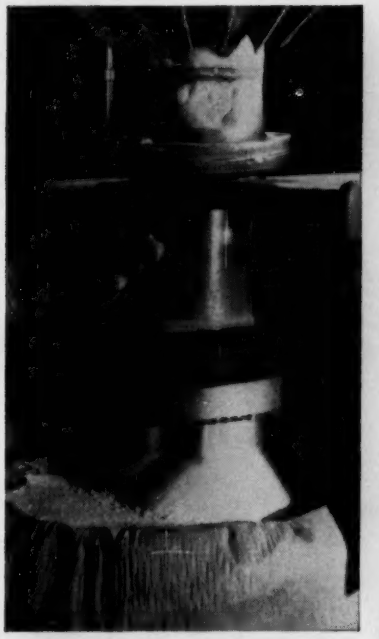
It's relatively easy to handle. You can store it without having gas pressure build up in the container. You can purify it by distillation.

It's a yellow to slightly reddish heavy liquid with a definite set of physical properties. It contains 52.0 to 52.5% chlorine.

You can get some helpful tips on sulfur monochloride, and the many other Hooker chlorides, from our new technical bulletin *Hooker Chlorinating Agents.*

This 24-page bulletin describes typical reactions. It saves you time with a quick comparison of physical properties.

Check the coupon for your copy and for the sulfur monochloride data sheet, too.



K_2CO_3 . . . WITH PACKAGE-PROTECTED PURITY

The extremely high purity of Nialk® carbonate of potash makes it the natural choice of men who make TV tubes, optical glass, and other glass products that must be bright and clear.

We protect that purity with a special package—from the time it leaves our plant and as long as it stays in yours.

Every barrel, fiber drum, and bag that contains our solid carbonate of potash has a moisture-resistant lining.

We ship larger amounts in 50-ton dry-chemical hopper cars, specially designed to preserve purity.

If you'd like description, typical data, and specifications on Nialk carbonate of potash, just check the coupon.

SODIUM BENZOATE . . . A FAST FLAKE IN SOLUTION

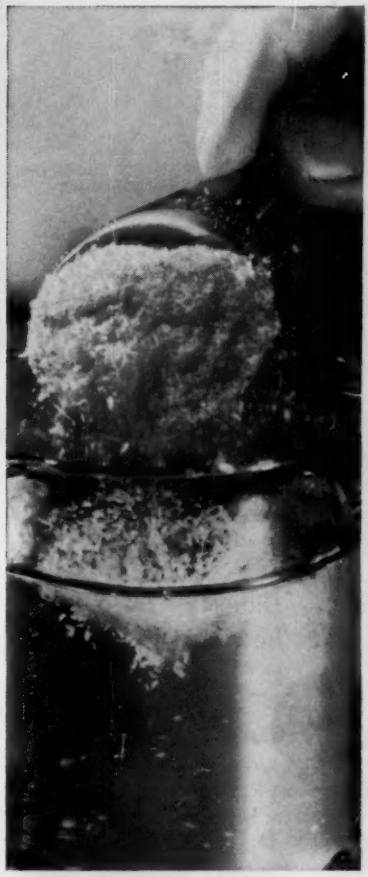
If you'd like a sodium benzoate that dissolves faster than the powdered form, you might consider a switch to Hooker flakes.

As you see here, this flake form starts dissolving as soon as it hits the water.

Thanks to an unusually careful flaking-screening operation, the Hooker flake stands shipping well and won't dust.

It comes in two grades: U.S.P. grade is over 99% pure, contains a max. of 0.2% benzoic acid, 0.5% water. Technical grade is also a high-quality material at 98% purity, with 0.4% benzoic acid max., and the rest water.

You can get either grade in powder form, too. For data sheet, check the coupon.



For more information, check here and mail with your name, title and company address.

☐ Sulfur Monochloride Data Sheet ☐ Technical Bulletin 328-B, *Hooker Chlorinating Agents* ☐ Carbonate of Potash Data Sheet
☐ Sodium Benzoate Data Sheet

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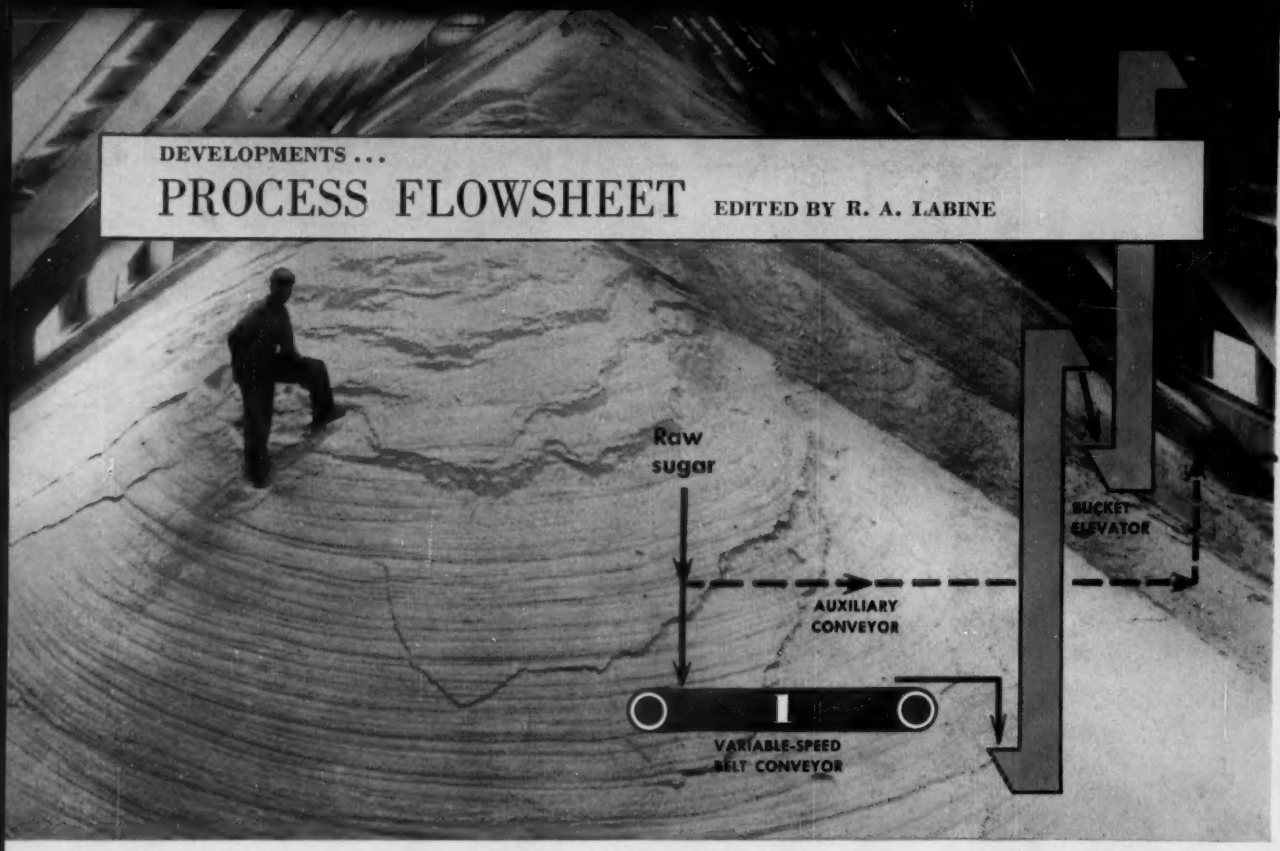
HOOKER CHEMICALS PLASTICS



RAW CANE SUGAR (40 million lb.) is piled in Imperial's warehouse. It feeds to the melt house via belt conveyors.

Melt House Redesigned for Automatic Flow

Imperial Sugar Co.'s new instrumented sugar refinery shows how this industry adapts the latest control ideas.

Changes are hitting the sugar industry. You may not be able to see the difference when your wife pours a cup of sugar into her favorite cake recipe, but the industry is making drastic changes in the way it gets the sweet white crystals ready for the supermarket shelf.

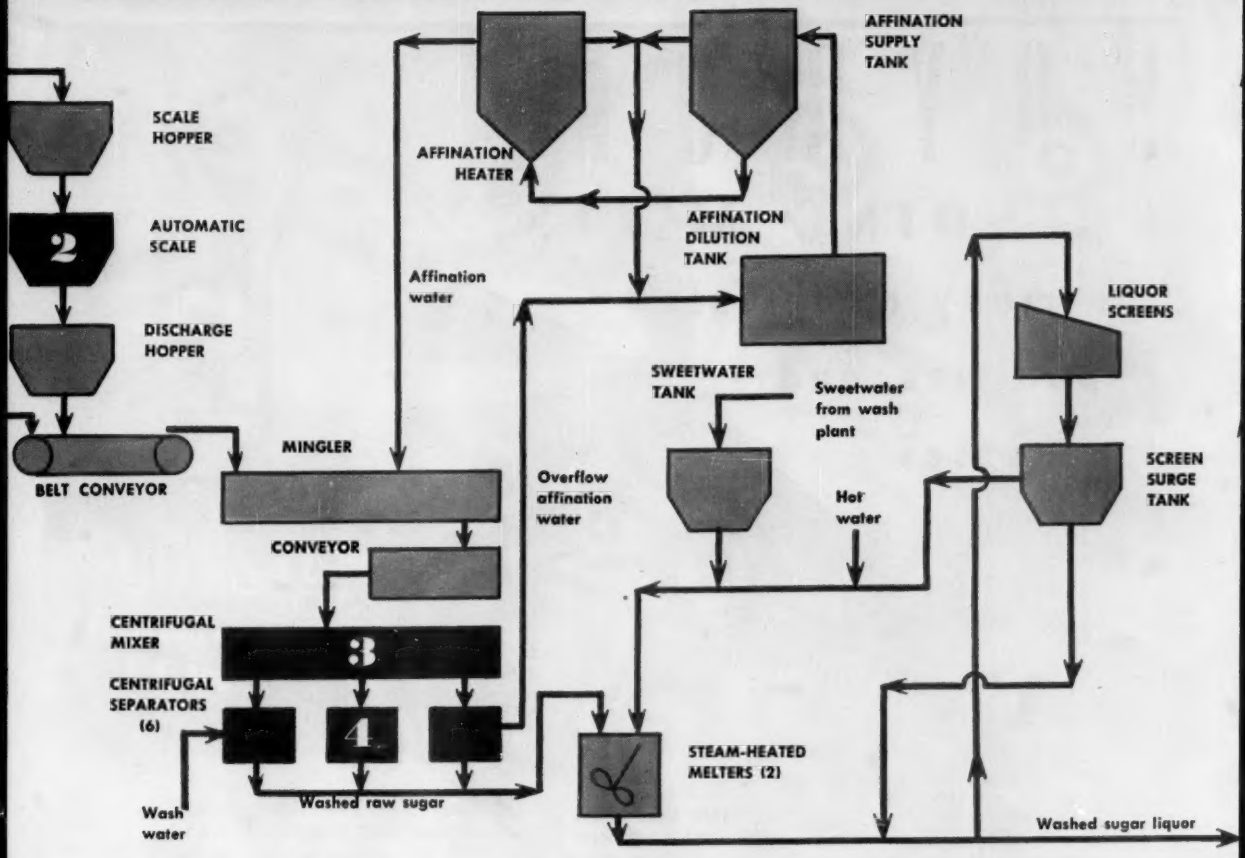
As in most of the chemical process industries, sugar refiners are investing more and more in instrumentation and continuous processing equipment to boost productivity and product quality while shaving operating costs. A good illustration of this trend is Imperial Sugar Co.'s 2.5-million-lb./day sugar refinery at Sugar Land, Tex., near Houston.

To its existing refinery Imperial recently added a highly instrumented $2.1-million melt house and raw sugar handling system. On stream for almost a year, the seven-story melt house is designed for automatic process control, giving a more consistent product at higher efficiency than ordinary melt house practice.

▶**Over the Waves**—Raw sugar for the Imperial refinery arrives at Galveston piers in ocean freighters from Hawaii, Cuba, Puerto Rico and Louisiana. At Sugar Land, Imperial can store 40 million lb. of raw cane sugar—enough for 16 days' operation—in its 340 ft. x 80 ft. x 60 ft. warehouse.

Raw sugar, with an average sucrose content of 98%, is conveyed from the warehouse on rubber belts which dump into two single-chain bucket elevators reaching to top floor of melt house.

Unfold Flowsheet



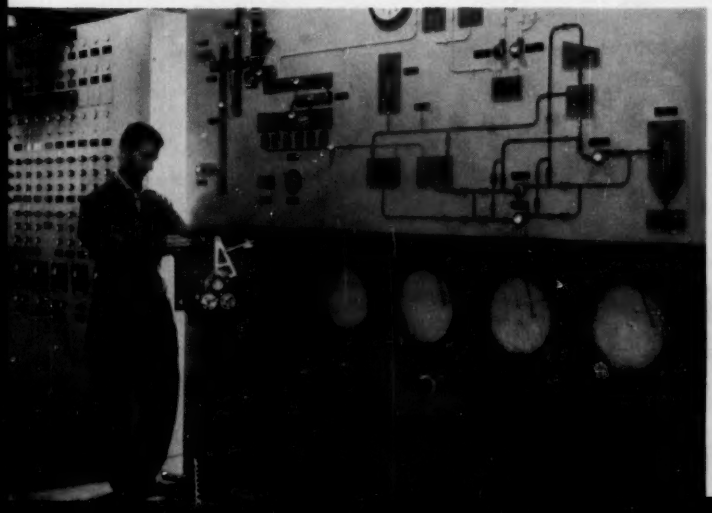
Warehouse conveyors are located in tunnels beneath the floor and can take sugar from any of 15 warehouse hoppers. All sugar entering the melt house is weighed on an automatic scale which weighs out 4,000-lb. batches.

Speed of tunnel belt feeding the raw sugar is controlled by level of magma* in the centrifugal machine feed mixer. A bin eye—located on the automatic scale supply bin—can stop conveyor if sugar level in bin gets too high. From scale weigh bin, sugar falls onto a short belt conveyor which has an automatically positioned gate controlled by level of magma in mixer (as are the tunnel conveyors).

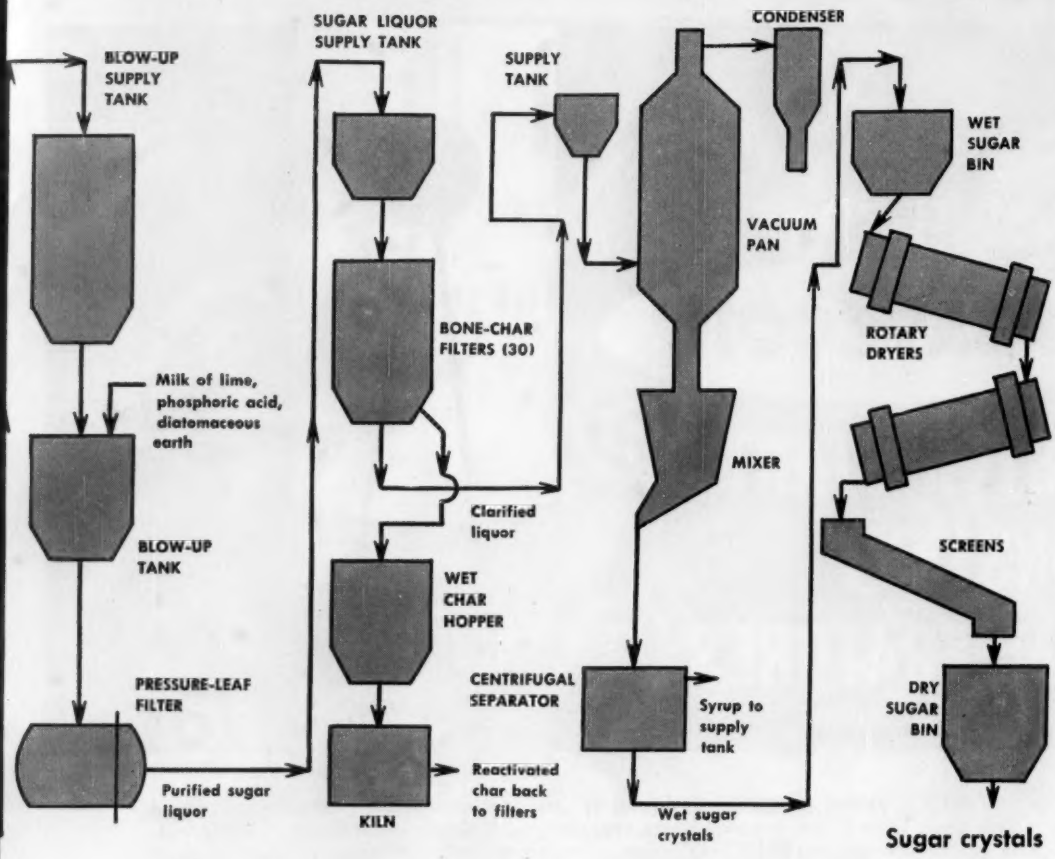
► **Mingling the Magma**—To help soften the molasses film around the raw sugar crystals and reduce

*Magma is the refiner's term for the mingled mass of raw sugar and sugar water (called affination syrup).

CONTROL PANEL
One operator can monitor operation of the seven-story process.



BELT CONVEYORS
Belts withdraw sugar from an



he amount of hot wash water needed in the centrifuging step, affination water is added to the ugar in the mingler. Affination water comes rom washings from melt-house centrifugals.

The mingler has a 50-hp. motor drive with peed-reduction train which turns a shaft with ariable-pitch blades in the trough. Imperial engineers originated this variable-pitch idea when riginal mingler gave more conveying action than desired. On feed end of trough, paddle pitch is set to give enough conveying to get magma quickly into the mixing section. Final magma has a consistency of 93 deg. Brix (roughly percent solids).

Warm affination syrup feeds to mingler at a rate of 1 lb. syrup to 2.5 lb. raw sugar. Rate of affination addition is controlled by power load on the motor which drives the mingler.

of 15 warehouse bins.

2 AUTOMATIC SCALE
Raw sugar is charged to the melt house in 4,000-lb. batches.

3 CEN
Mag

▶**Mix and Centrifuge**—Magma flows from mingler to a centrifugal mixer where it is agitated by a rotating coil in the bottom of the trough. Hot water flowing through the coil keeps magma at a constant 115 F.

Mixer supplies six fully automatic centrifugal separators where a combination of hot wash water and centrifugal force loosens impurities clinging to the raw sugar crystals. Centrifugals have a capacity of 15.7 cu. ft. per machine and are rated at 600-1,200 rpm. Units operate in sequence and total washing cycle can be controlled from a minimum of 150-210 sec. up to a maximum of 420 sec.

Length of centrifugal cycle is controlled by level of melt liquor in the blow-up supply tank located 1,500 ft. away in the refinery building. For example, centrifuge starting time can be delayed up to 120 sec. if melt liquor supply tank is over 70% full; centrifuges are stopped if tank reaches 90% level. Typical cycle runs 39 sec. for preflushing, loading and first wash. Depending on plant need for sugar, next time segment can be pre-set between 150 and 210 sec. Second wash, drying, braking and discharge take about 115 sec.

▶**Washing for Purity**—In centrifugal wash cycle, sugar crystals are washed with 200 F. water. Affination water from these units is recycled to the supply tank for heating and then addition to the mingler. Affination syrup is made at a rate of 11-12% of raw sugar melt rate.

Product from the centrifugals is washed sugar which discharges into one of two melters—steel tanks 12 ft. dia. holding 3,800 gal. Here, sugar dissolves in sweet water† and hot water as needed. Melt tank temperature is controlled at 185 F. and 62.5 deg. Brix; tank level is controlled by demand of the refinery.

Melting alternates every 24 hr. between the two tanks so they can be cleaned out. Reciprocating steam pumps force melt liquor over a shale shaker screen (commonly used in oil field mud screening) at a rate of 300 gpm. Screened liquor flows from screen surge tank in melt house to the refinery building through another reciprocating steam pump.

▶**Designed for Flexibility**—Most equipment in melt house is designed for a raw sugar melt rate of 75 tons/hr. (3.6 million lb./day). Plant is currently operating at 2.5 million lb./day with three shifts per day, five days per week minimum. Plant swings to a six or seven-day work week during peak summer demand periods.

All melt-house controls are pneumatic. Throughout the process, interlock controls are designed to allow equipment to cut itself off or come back on progressively as demanded by operating conditions. With all conditions at optimum, entire plant operates automatically from start-up to shut-down. A single operator on the second floor can monitor operations in the whole seven-story melt house.

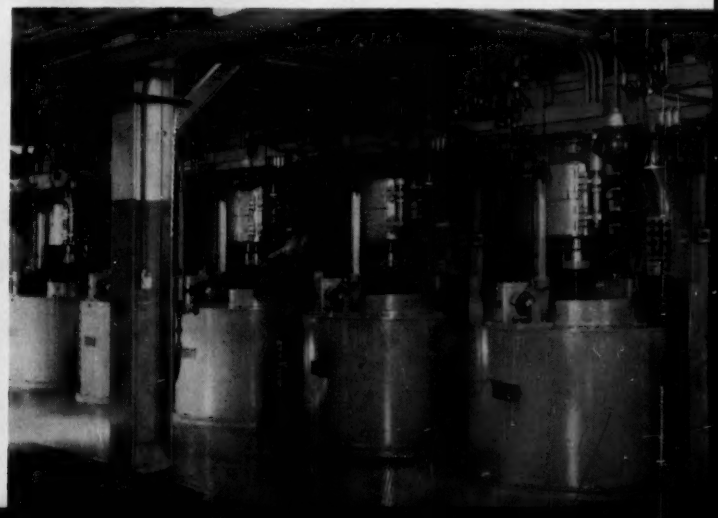
▶**Finishing Up**—Washed sugar goes through conventional steps in rest of the refinery.

Phosphoric acid, milk of lime and diatomaceous earth filter aid is added in the blow-up tanks. Then follow pressure filtration, bone-char decolorization, vacuum pan evaporation, drying and granulation to make many grades of refined cane sugar —from dark brown to white to liquid sugar.

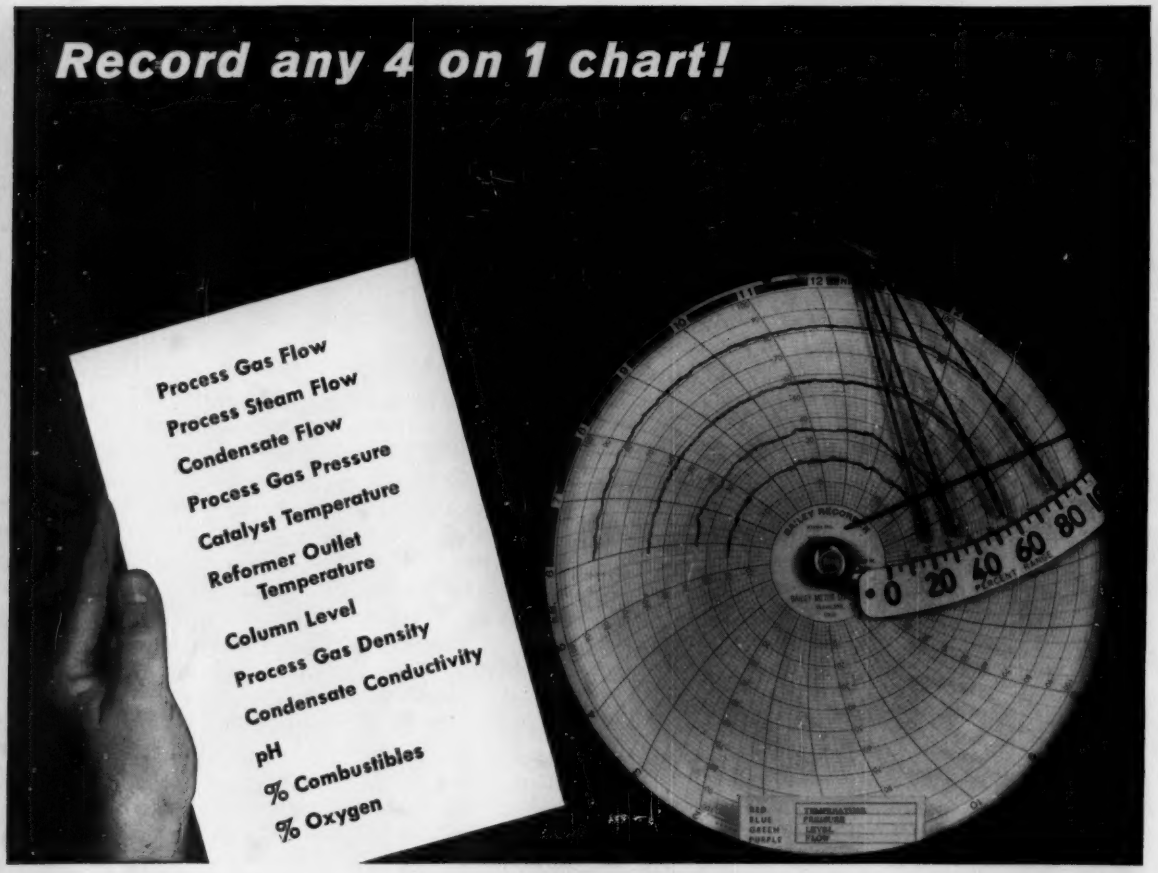
Current trend for many large users is to buy sugar in bulk quantities which is transported from the Imperial plant in specially built railroad cars and motor trucks.

†Any water with a small amount of dissolved sucrose from refinery operations, such as from pressure filters, vacuum pan steamouts, and condensate traps.

CENTRIFUGAL MIXER
Magma, kept at 115 F., feeds to centrifugals at left.



CENTRIFUGAL SEPARATORS
Impurities are washed from sugar crystals.



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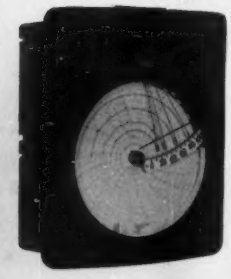

Records four variables on one chart.

You can lower the cost of your equipment investment and increase the efficiency of your entire operation with the Bailey Receiver Recorder.

HERE'S HOW

The interchangeable components for the Recorder make it fast, inexpensive, and automatic to do up to *four* measuring jobs at the same time with either or both pneumatic and electric systems.

This Bailey unit continuously and simultaneously records four variables on the same chart. And, they are *in the same linear scale measurement.* You have clear, easy-to-read records for continual analysis and control.

Plug-in, pre-calibrated receivers can easily be adapted on-the-job to revised process requirements. The Bailey Receiver Recorder saves you money with a minimum instrument investment for process cycle expansion or alteration. Let your local Bailey engineer suggest applications to fit your operation. Or write for specific control systems information for your entire plant operation.

CP105-1

Chemical and petroleum division

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MULTI-ZONE

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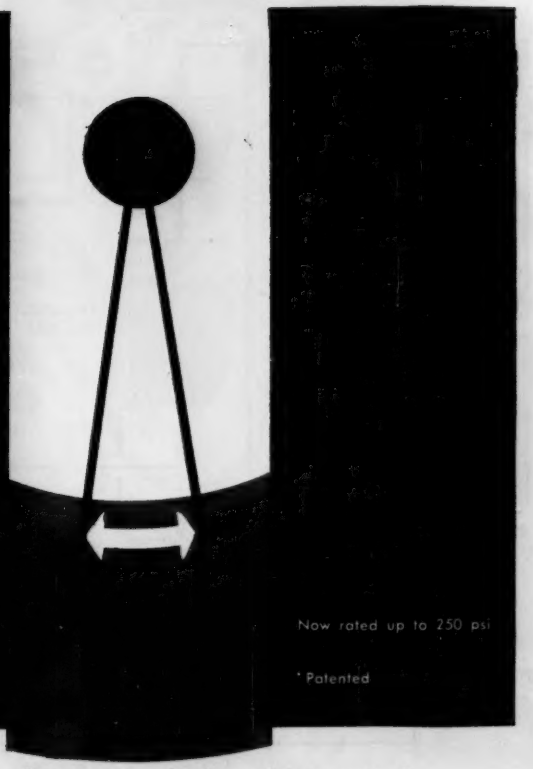
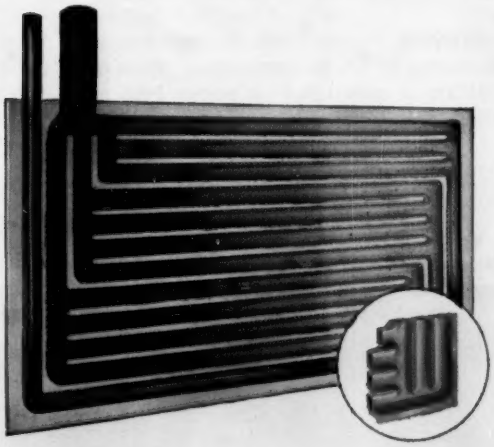
FASTER START-UP, CONSTANT TEMPERATURES



The new MULTI-ZONE design cuts "downtime" and compensates for intermittent overload in a wide range of tank and process heating applications. Multiple headers and multiple condensate returns provide for FREE-FLO action — with practically instantaneous distribution of steam to all levels of the plate. Condensate "trapping" is held to a minimum. This gives the new MULTI-ZONE PLATECOIL a reserve capacity to deliver under overload conditions during "start-up." It also produces extremely fast recovery of tank temperature with minimum variation.

IN ALL KINDS OF TANK AND PROCESS HEATING



Operating Pressures up to 250 psi — DURAWELD bonding of the plates and mill-controlled TRANSTEEL in standard units have boosted PLATECOIL pressure containment rating up to 250 psi. This makes the time-proven advantages of PLATECOIL applicable to many types of heating where 250 lb. steam is required. Destruction tests have demonstrated a safety factor of 5 to 1.

Low Installation and Maintenance Costs. — PLATECOIL costs are low compared to the cost of engineering, fabricating, installing and maintaining pipe coils. Lightweight, compact PLATECOIL simplify installation. Greater heat transfer per sq. ft. of surface permits smaller units which save valuable tank space. Streamlined surfaces cut cleaning costs. Integral, factory fabricated construction eliminates threaded joints (in the solution) to corrode or leak. All stainless steel and alloy PLATECOIL units affected by cold working are annealed and pickled after fabrication to return the metal to its original condition and thus eliminate the probability of corrosion due to internal stresses and carbide precipitation.

Write for NEW PLATECOIL Bulletin ***P61 for more data.***

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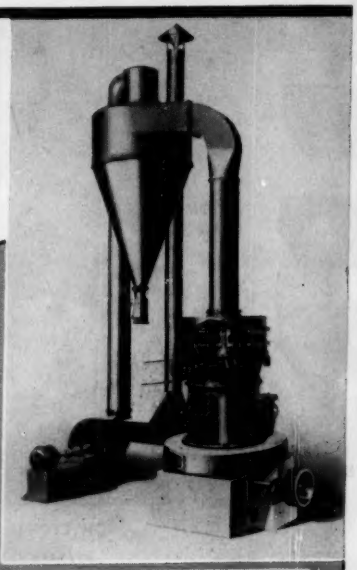

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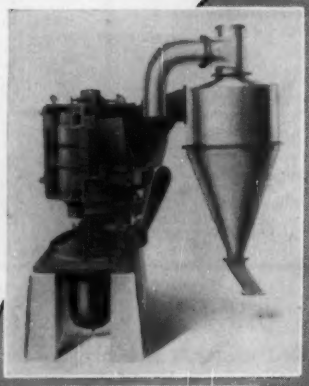

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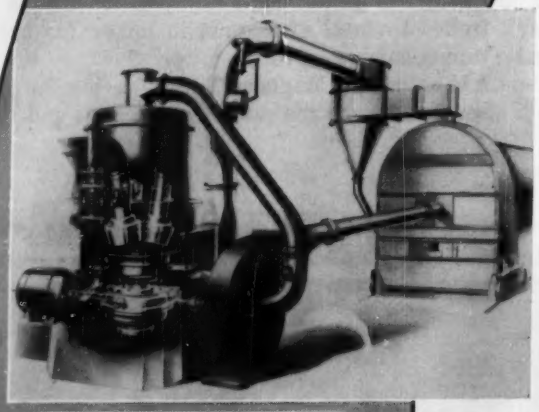

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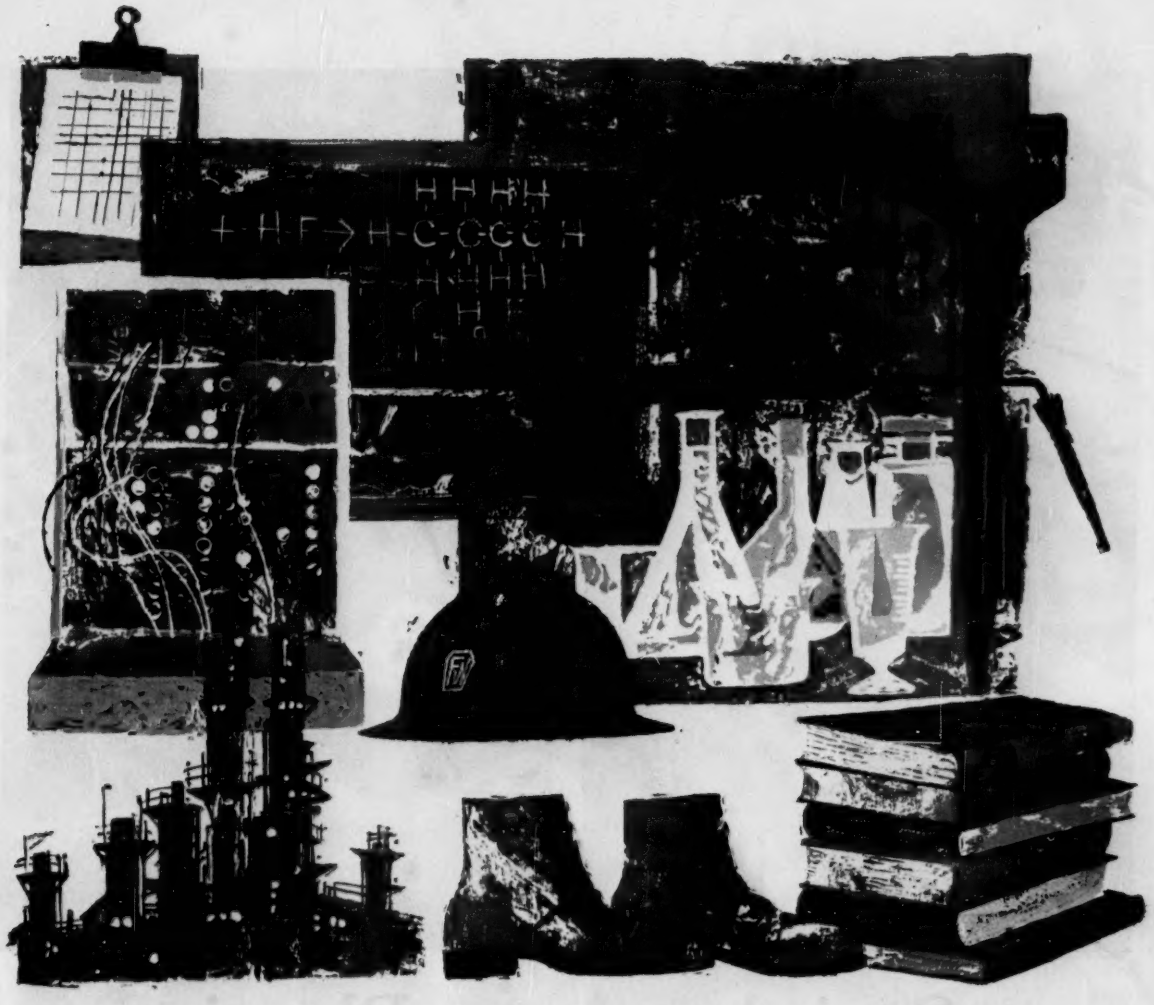

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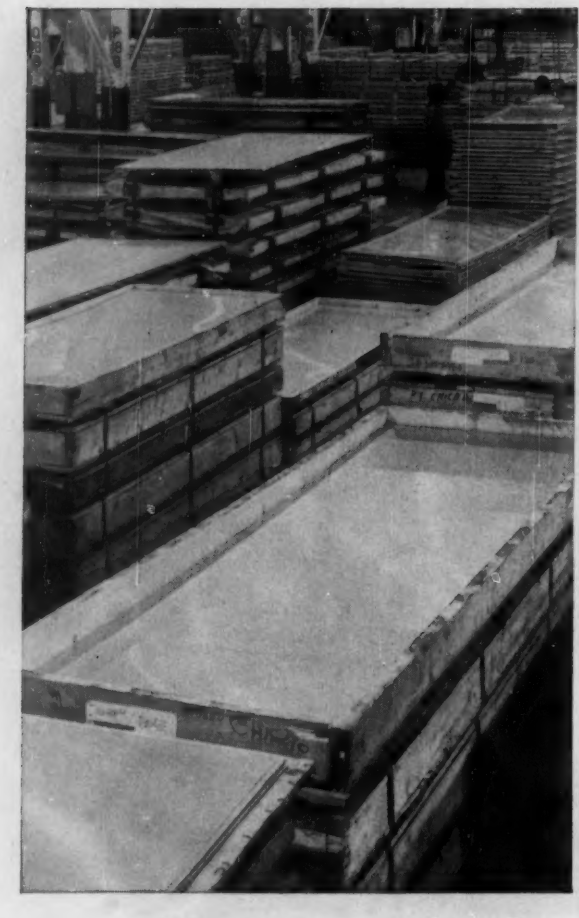

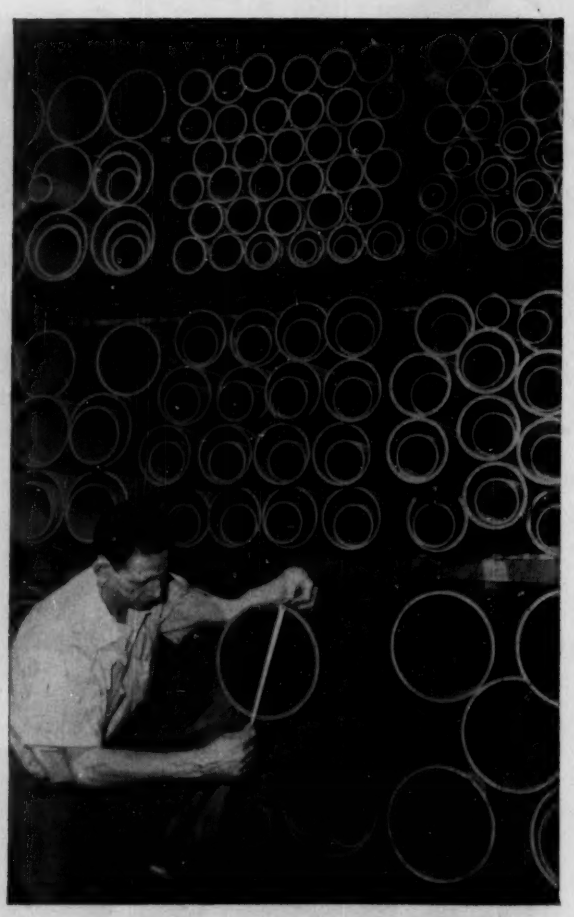

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Chemical Engineering
MAY 2, 1960

NINTH INVENTORY

New Processes and Technology

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HERE'S your guide to significant technical developments in the chemical process industries for the period starting with March 1958. Almost 300 listings are included in this ninth *CE* process inventory, each item condensed to its factual core. Carefully screened to put you on top of latest developments, our selective directory covers only projects that have been made public and that have reached an advanced stage of development.

Fine Organic Chemicals

Product	Process	User	Features	Remarks
Amylose, amylopectin	Salting out.....	Avebe Veendam, The Netherlands	Process separates amylose and amylopectin in potato starch by cooking in $MgSO_4$ solution, separates amylose by cooling, salts out amylopectin with $MgSO_4$.	35,000 lb./day amylopectin and 12,000 lb./day amylose. First commercial quantities of amylose.
Anthraquinone...	Naphthalene oxidation	American Cyanamid Co. Bound Brook, N. J.	Naphthalene is directly oxidized to napthoquinone and phthalic anhydride on fixed catalyst bed. Separated in absorption-extraction system, naphthoquinone can react with butadiene for anthraquinone or with other materials to make substituted anthraquinones.	.....
Anthraquinone...	Catalytic oxidation	American Cyanamid Co. Bound Brook, N. J.	Direct oxidation of naphthalene in fixed bed catalytic converter will produce anthraquinone.	On stream 1959. Only U. S. plant.
Aryl mercaptan...	Refining.....	Consolidation Coal Co. Newark, N. J.	Process uses aryl-mercaptan-rich byproduct stream from cresylic-acid refining plant.	In pilot plant.
Citric acid.....	Deep fermentation	Miles Chemical Co. Elkhart, Ind.	Air is blown through fermentation tanks in which mold grows on a sugar solution. Differs from Pfizer's shallow-pan fermentation process.	Miles has 15 million lb./yr. plant in operation using process.
Cyanosilicones....	Addition.....	Union Carbide Chemicals Co. So. Charleston, W. Va.	In a typical reaction, trichlorosilane can be added to acrylonitrile. The cyanoalkyl chlorosilanes are hydrolyzed and partially condensed to siloxane polymers which are further condensed to cyanosilicones.	Can be produced as fluids, solutions, pastes, solids for adhesives, sealing and caulking, and vehicle components.
Dextrins.....	Fluidization.....	A. E. Staley Mfg. Co. Decatur, Ill.	Fluidization of dry, powdered starch in air permits even distribution of heat and acid. Better control of starch-to-dextrin conversion prevents localized charring.	Produces higher quality dextrins (lighter color, more uniform) for use as coatings, adhesives, dyeing agents.
Dialdehyde starch	Starch oxidation.	Miles Chemical Co. Zeeland, Mich.	Periodic acid, made from iodine in an electrolytic cell, is used to oxidize starch; iodate recycles to the cell. Product has applications in tobacco (making tobacco sheets), adhesives and binders, films, coatings, paper, textiles.	Miles has a semicommercial plant with a 250,000 lb./yr. capacity in operation. Licensed by U. S. Dept. of Agriculture.
Dimethyl isophthalate	Esterification.	Montrose Chemical Co. Newark, N. J.	Probable reaction route: Isophthalic acid (solid) and methanol (vapor) react in pressurized, heated vessel. Methanol plus water distill over; dimethyl ester goes to distillation and final purification to 98.0% plus.	Plant turns out several million lb./yr.
Diphenolic acid...	Condensation....	S. C. Johnson & Son Racine, Wis.	Two moles of phenol react with one mole of levulinic acid in presence of hydrochloric acid which acts as condensing agent. DPA molecule has eight reactive sites, shows special promise in coatings.	Produced on pilot scale of 125 tons/yr.

Fine Organics—Continued

Product	Process	User	Features	Remarks
Ethylenediaminetetraacetic acid (EDTA)	.....	Hampshire Chemical Co. Nashua, N. H.	Starting with hydrocyanic acid, formaldehyde and ethylenediamine, new process produces EDTA and its derivatives more economically than older chelate-producing processes.	Newly-formed Hampshire Chemical pins hopes on penetrating chelate market with process.
Fatty nitrogen compounds	.....	Archer-Daniels-Midland Co. Minneapolis ,Minn.	Starting with fatty acid, process differs from others in the way it makes intermediates; it can make both nonsymmetrical and symmetrical tertiary amines, others make only the nonsymmetrical variety.	Full-scale production.
Fluoroalcohols....	Telomerization...	Du Pont Co. Wilmington, Del.	Process involves free radical telomerization of tetrafluoroethylene in methanol, produces C_3 and C_5 fluoroalcohols.	Commercial plant in operation.
Fumaric acid.....	Fermentation....	Taft Sanitary Engineering Center Cincinnati, Ohio	Fermentation of sugar in sulfite liquor can give 40% weight yield on sugar, greatly reduce BOD of liquor.	Experimental. Liquor from 200 T/day of pulp would satisfy U. S. fumaric acid needs at lower cost.
dl-Glutamine.....	Synthesis.....	Eli Lilly & Co. Indianapolis, Ind.	Condenses α-ketoglutaric acid with hydrazine and then hydrogenates the cyclic intermediate to dl-glutamine	Cuts cost of dl-glutamine 10 fold.
Lactic acid.....	Solvent extraction	Bowman Chemicals, Ltd. Widnes, England	Fermentation product purified by precipitation with sulfuric acid, ion exchange, and distillation. Then treated with diisopropyl ether in continuous solvent extraction process.	In full-scale operation.
Monosodium glutamate	Fermentation....	Various	Various processes start with α-ketoglutaric acid and urea; citric acid and NH_3; sugar; sweet potatoes. Merck is building $4.5-million plant for fermentation from sugar.	Present commercial processes based on chemical isolation from natural products.
Protein.....	Solvent extraction	.....	Adaptation of Blaw-Knox vapor desolventising-deodorizing process for treating oil-extracted flakes at low temperature.	In use by Japanese, process produces higher percentage (80–85%) of soluble protein from seeds.
Polyphenyls.....	Zone-refining purification	L. Light & Co. Colnbrook, England	Manufacturer freezes polyphenyls (e.g. anthracene, stilbene, terphenyl), then zone-melts frozen solid. Batch size is 1–5 lb.	Products used to grow crystals that are made into scintillators.
Parachloro thiophenol	.....	Stauffer Chemical Co. Henderson, Nev.	Process, claimed to be radically new, is most likely a variation of classical route—chlorosulfonation of chlorobenzene, followed by reduction to the thiol.	Building of a $500,000 plant to produce this insecticide chemical is under way.
Protein, soya.....	Precipitation.....	Central Soya Co. Chicago, Ill.	Defatted soya flakes (55% protein) are treated with water. Insoluble residue is discarded and the solution is acidified to precipitate protein, leaving bulk of impurities in solution. Protein is filtered, reslurried and spray dried, producing "tasteless" 93% pure product.	Central Soya plant turns out several million lb./yr. as additive for bread, babyfood, cereal.
Steroids, substituted	Substitution reactions	Upjohn; Syntex Resp. Kalamazoo, Mich. and Mexico City, Mexico	6-alpha-fluorine substituted steroids are synthesized as both mono- and difluoro compounds. Upjohn and Syntex go through a 5,6-epoxy stage using peracetic acid. Upjohn starts with methyl pregna-4,17-(20)-diene-3, 11-dione-21-oate; Syntex starts with cortisone.	Pilot plant stage.
Tetracycline derivative	Total synthesis...	Lederle Labs Div., American Cyanamid Co. Pearl River, N. Y.	Total synthesis of biologically active compound, a derivative of dimethyl chlortetracycline, chemically related to naturally derived broad-spectrum antibiotics.	Lederle claims achievement opens up pathways to new antibiotics independent of living organisms.
Tetraethyl lead...	Cyclic process....	.....	Reaction of metal-organics (ethyl sodium) and nonhalide lead compounds (lead acetate) in presence of cadmium acetate and ethyl iodide results in virtually 100% yields of tetraethyl lead.	Under development by Ethyl Corp.
Tetraethyl lead...	Electrochemical..	Max Planck Institute Muelheim-Ruhr, West Germany	Sodium hydride, formed from sodium metal hydrogenated in a liquid hydrocarbon, reacts with ethylene and alkylaluminum under low voltage in an electrolytic cell. Tetraethyl lead yield runs 96–97%.	.....

Heavy Organic Chemicals

Product	Process	User	Features	Remarks
Acetylene derivatives	.....	Lakeside Labs Milwaukee, Wis.	Basic acetylenic halide (e.g., propargyl bromide) reacted with an amine (e.g., diethylamine) to produce 3-diethylamino-1-propyne. The latter is reacted with sodium amide and a halogen-substituted amine (e.g., 3-diethylamino-1-chloropropane) to yield 1,6-bis (diethylamino)-2-hexyne. New route permits synthesis at atmospheric pressure and moderate temperature.	Moving into 4,000-lb./yr. semiworks unit. Aldrich Chemica will market new products—acetylene-derived, unsymmetrically substituted diamines.
Acetic acid.....	From black liquor	Sonoco Products Hartsville, S. C.	Black liquor from pulping operations is converted to acetic and formic acids, reducing stream pollution problems.	Commercial.
Acetaldehyde...	Direct oxidation.	Consortium fuer Elektrochemische Industrie, GmbH Munich, Germany	Ethylene-containing gas stream reacts in tower with 0.1M aqueous solution of palladium dichloride. Yield of acetaldehyde is over 90%. Spent catalyst regenerated by air oxidation.	Advantages are ability to use cheap raw materials and low capital investment. Tested through pilot stage.
Acrylonitrile.....	Ammonia-propylene	Sohio Chemical Co. Lima, Ohio	Anhydrous ammonia and air react with propylene when passed through fluidized catalytic bed at temperatures under 500C., pressures under 3 atm. Process yields acrylonitrile directly with byproduct HCN and acetonitrile in usable quantities.	Sohio plans push outside U. S. Economic studies made with Badger Mfg. (Cambridge, Mass.) and Badger, N.V. (The Hague) show process competitive, especially for small plants.

Heavy Organics—Continued

Product	Process	User	Features	Remarks
Acrylonitrile monomer	Dehydration	Knapsack Griesheim AG. Germany	Starting with acetaldehyde and hydrocyanic acid, process produces intermediate lactonitrile. Dehydration of lactonitrile instaneously, in presence of concentrated phosphoric acid, yields product.	Proved out with extensive runs in 30-ton/day plant.
Acrylonitrile.....	Nitrosation.....	Du Pont Co. Beaumont, Tex.	Reaction is a one-step vapor-phase nitrosation of propylene by nitric oxide in the presence of a dehydrogenation catalyst (e.g., silver on silica) at 850 to 950 F.	Plant to be in operation in 1961
Alcohols, straight chain	Catalytic (Alfol)..	Continental Oil Lake Charles, La.	Aluminum metal, hydrogen and ethylene react to form aluminum triethyl which reacts with more ethylene to form a series of aluminum trialkyls. Air oxidation, then hydrolysis, gives mixture of straight chain alcohols.	First plant to make straight chain alcohols from petroleum will be ready in 1961 using Alfol process. Capacity: 50 million-lb./yr.
Alcohols.....	Telomerization...	Union Rheinische Braunkolen Krafstoff AG. Cologne, Germany	Reaction of methanol or acetone with propylene or butylene via telomerization gives product alcohols in the C_8-C_{18} range. Reaction pressure is 750–900 psi. at temperature of 285 F. Catalyst is ditertiary butyl peroxide.	In pilot plant phase. Only lab phase in U.S.
Aniline.....	.....	American Cyanamid & Chemical Co. Willow Island, W. Va.	Vapor-phase reduction of nitrobenzene in single fluidbed reactor in about 1 min. with metallic copper catalyst on silica. Catalyst formed in silica gel which is spray dried. Catalyst activated in reactor at 250 C. in hydrogen atmosphere. Particle diameter 20–150 microns.	Operating in American Cyanamid plant at 24 million lb./yr. aniline capacity. U.S. Patent 2,891,094.
Aromatics.....	Catalytic dealkylation	.....	One-step catalytic process purifies and dealkylates aromatic light oils and produces high-purity benzene, toluene and xylene.	Developed by Houdry Process Corp., dubbed, "Litol."
Benzene.....	Hydeal (UOP)...	.....	Mixed-aromatic refinery feed mixes with hydrogen-containing offgas. Mixture is heated, then charged to dealkylation reaction where it contacts catalyst. Liquid effluent gives nitration-grade benzene on distillation.	Yields from toluene run 90–95%, from xylenes 85–90% theoretical. First UOP plant on drawing board.
Benzene, naphthalene	Hydrodealkylation	Ashland Oil & Refining Co. Buffalo. N.Y.	Process is first to produce synthetic benzene and naphthalene by dealkylation of alkyl benzene and alkyl naphthalene; was developed by Ashland.	Plant scheduled for Buffalo to make 50 MM lb./yr. of naphthalene or 12 MM lb./yr. of benzene, or combination of both.
Caprolactam.....	.....	Commercial Solvents Corp. Peoria, Ill.	Process details not available. Uses equipment and by-product feed already available in Peoria installation.	Developed by CSC and in production of limited volume.
Caprolactam.....	Synthesis.....	Du Pont Co. Beaumont, Tex.	Using petroleum derivatives, Du Pont will make caprolactam by new process that will lower price considerably and produce cyclohexylamine coproduct.	50 MM lb./yr. plant due for startup in third quarter of 1960.
Coconut oil.....	Centrifugal refining	.....	Oil and lye, separately preheated, are reacted in a high-speed mixer and then centrifuged. Refined oil is water-washed, centrifugally separated again and vacuum dried.	Process, developed by DeLaval Separator Co., uses completely air-free pressurised system with pressure centrifugal.
Char, high carbon.	Medium temperature coal carbonization	Koal Krudes, Inc. Red Lodge, Mont.	Continuous process carbonizes bituminous coal at 1,200 F., compared with 1,500 to 2,000 F. for conventional batch process.	100,000-ton/yr. plant never ran commercially. Product intended for reduction of phosphate rock in electric furnace. Process was in pilot plant 3 years.
Detergents.....	Sulfonation-sulfation	Chemithon Corp. Seattle, Wash.	Aryl alkylate is first sulfonated with oleum, then fatty alcohol is added and sulfated with excess H_2SO_4 from sulfonation stage. Process yields combination detergent combining properties of both alkyl-aryl sulfonates and fatty alcohol sulfates.	Commercial.
Diabasic acids ...	Direct oxidation..	Amoco Chemicals Corp. Joliet, Ill.	Direct oxidations of mixed alkyl aromatics produce the aromatic acids—phthalic, isophthalic and terephthalic. Liquid-phase air oxidation involves use of a heavy-metal, e.g., cobalt, manganese or molybdenum—used in form of salts and some form of bromine as catalyst.	60 million-lb./yr. plant is nearing startup. Mitsui Petrochemical (Japan), Imperial Chemical Industries (England), and Maruzen Oil (Japan) have plants using process under way.
N, N-Dimethylhydrazine	Catalytic reduction	Aerojet-General Corp. Sacramento and Azusa, Calif.	Rocket fuel made by reaction of N-nitrosodimethylamine with gaseous hydrogen in the presence of palladium.	Over 15,000 lb produced in pilot plant.
Ethanol.....	Alkene hydration.	Farbwerke Hoechst AG. Frankfurt, Germany	Ethylene is absorbed by 68–72 wt. % H_2SO_4 in column at 20–40 atm., 140–160 C. Water is added in amount equal to alcohol concentration, 7%, and alcohol recovered in 2-stage vacuum stripping. Yield is 96% based on starting olefin; H_2SO_4 doesn't need reconcentration before recycle.	Also produces isopropanol from propylene, at 70-110 C. absorption temperature, 20–30% water concentration.
Ethyl benzene....	Catalytic (Alkar).	Eastern States Petroleum & Chemical Corp Houston, Tex.	Olefin-containing gas stream treated with benzene, alkylating olefins to ethyl benzene and cumene which can easily be separated from unreacted gases. Reaction takes place in fixed bed over unidentified catalyst.	Only outlet for ethyl benzene is styrene; process developed by UOP.
Ethyl benzene....	Catalytic.....	El Paso Natural Gas Co. Odessa, Tex	New solid phosphoric-acid catalyst containing kieselguhr is less corrosive and gives higher yields than previous alkylating agents.	Process developed by UOP, using a catalyst called UOP-4.
Ethylene oxide...	Direct oxidation with oxygen	Wyandotte Chemical Co. Geismar, La. Calcasieu Chemical Co. Lake Charles, La. Shell Chemical Co. Partington, Eng.	Oxygen is used to oxidize ethylene to ethylene oxide. A similar competing process, developed by Scientific Design, uses air. Controversy rages over the relative technical and economical merits of each process.	Process was developed by Shell Development, and is offered for licensing.
Ethylene oxide condensation products	Condensation....	Process Chemical Co. Los Angeles, Calif.	Condensates of ethylene oxide with nonyl phenol, 2-ethyl-hexanol, long chain synthetic alcohols, various amines.	4.5 million lb./yr.
Formaldehyde....	.....	Montecatini Chemical Co. Castellanza, Italy	Methanol oxidation uses metallic-oxide catalyst instead of silver. No stripping, rectification alcohol needed.	To expand production from 36,000 to 60,000 tons/yr.

Heavy Organics—Continued

Product	Process	User	Features	Remarks
Isosebacic acid...	Sodium dimerization of butadiene	U. S. Industrial Chemical Co. Tuscola, Ill.	Isosebacic acid is based on dimerizing unsaturated hydrocarbons such as butadiene with sodium. Key step: Suppressing polymerization in favor of dimerization. Process includes dimerization, carbonation, hydrogenation.	Commercial plant that was planned has been cancelled.
Melamine.....	.....	Société des Produits Azotes (France)	Calcium carbide is conventionally converted to dicyandiamide. New twist is that after solid dicyandiamide is heated to over 100 C. It's reacted with gaseous ammonia under pressure.	Patented in Australia.
Microcrystalline wax	Decolorizing.....	Western Petrochemical Corp. Chanute, Kan.	Uses Mobil Oil Co.'s continuous Thermofor Percolator to decolorize wax, the first such operation in U. S. Absorbent from moving bed contactor is continuously washed, dried and regenerated by calcination.	Offers some cost advantage over competitive systems.
Naphthalene.....	Crystal fractionation	Dorman Long (Chemicals) Ltd. Port Clarence, Middlesbrough, England	Crystallization wins naphthalene from sulfur-laden, crude tar distillate. Crystals separated as finished, commercial-grade product via centrifugating with hot-water washing.	Process, developed by Proabd Ltd., yields 30 tons/day.
Paraxylene.....	Octafining.....	Mitsui Petrochemical Industries, Ltd. Tokyo, Japan	Developed and pilot planted by Atlantic Refining, process boosts C_8 streams, paraxylene yield by subjecting stream to octafining after all but 7–10% para has been removed. Octafining: Treatment with H_2 under pressure in presence of platinum-silica-aluminum catalyst brings stream against 20% para. Stream again to fractional crystallizer.	Plant under construction.
Perchlorethylene..	Chlorination.....	Pechiney St. Auban, France	Chlorocarbons exiting from chlorination furnace are rapidly chilled with HCl, minimizing side product reactions and yielding considerable HCl for recovery Organic chloride liquid processed to recover perchlorethylene. One-step process vs. previous four-step.	20-million lb /yr. plant on stream. Yields close to theoretical.
Phthalic anhydride	Fluid bed.....	American Cyanamid & Chem. Co Bridgeville, Pa	Fluidized operation with new vanadium catalyst works at lower temperature than fixed-bed operation; this minimizes pollution problem, byproduct formation, simplifies heat exchange	35–40 million lb./yr. capacity. Product 97–99.5% pure phthalic vs. 94.5–96% from fixed bed.
Propellant, solid..	Plastisol system..	Atlantic Research Corp. Alexandria, Va.	Slurry of plasticizer oil, plastic spheres (1 micron dia.) and a propellant oxidizer is solidified by 350 F. heat. Plasticizer oil fuses with plastic, forming a uniform mass in which the oxidizer is imbedded.	Claim excellent shelf life. Working on continuous method where components are mixed, heated and extruded.
Silicones.....	Continuous synthesis	General Electric Research Laboratory Schenectady, N. Y	New catalyst, tetrabutylphosphonium hydroxide, makes possible the switch from batch to continuous operation in making silicone oils and gums.	Prepilot size units.
Sucrose derivatives	Esterfication.....	Eastman Chemical Products Co. Kingsport, Tenn.	Process makes sucrose acetate isobutyrate, other sucrose derivatives, via esterification using sucrose, isobutyric anhydride and acetic anhydride.	1,000 lb./week plant on stream, large facility planned.
Sugar.....	Diffusion.....	.....	Relies on osmosis to transfer sugar from the cells of cane chips to a water phase, extracts over 96% of sucrose. Cane slurry goes into the bottom of a diffusion tower is picked up by a revolving scroll which moves solids upward. Liquid flows countercurrently, sugar solution leaves bottom of tower.	Developed by Chemetron in a Fellsmere, Fla., pilot plant.
Sugar.....	Automatic affination	Imperial Sugar Co. Sugar Land, Tex.	Interlocking control system coordinates input data, regulates length of centrifugation cycle according to level of affinated (washed) sugar liquor in storage.	Completely automated, $1.2 million melt house on stream.
Synthesis gas	Partial oxidation..	.....	Oxygen partially oxidizes fuel oil to CO-H_2 synthesis gas in a special burner. Pressures range from 75 to 500 psi. and temperatures from 2,000 to 2,700 F., depending on feedstock.	Developed by Shell, process up for sale as single packaged plant. Similar to Texaco process.
Terephthalic and isophthalic acids	Alkylation and oxidation	.....	Alkylation of benzene and propylene over silica-alumina catalyst produces para- and/or meta-diisopropylbenzene (DIPB). Terephthalic and/or isophthalic acid of high purity is produced from DIPB by selective oxidation with air in acetic acid using a metal catalyst.	Process was developed by Shell Chemical, is under study by N. V. de Bataafsche Petroleum Maatschappij (Netherlands).
Terephthalic acid.	Henkel (streamlined)	Several	Benzene reacts with potassium carbonate under pressure at 350 C to produce potassium terphthalate. Reaction uses cadmium catalyst, and is carried out in presence of aluminum carbide, which keeps things dry.	Process thus substitutes benzene for costlier starting materials in old Henkel process.
Tar fractions.....	Solvent refining..	Consolidation Coal Co. Library, Pa.	Solvent refining of low-temperature tar makes available high-molecular-weight fractions which cannot be obtained by distillation.	Bench scale.
Urea.....	Total recycle.....	Toyo Koatsu Japan	Like Montecatini and Pechiney processes, Toyo Koatsu employs a liquid recycle, eliminating need for separation of unreacted NH_3 and CO_2. Unlike the two other processes, T-K absorbs NH_3 and CO_2 in ammonium carbonate, and pumps this stream back to autoclave.	Five plants now in operation; total output of 418,000 metric tons/yr.

Inorganic Chemicals

Product	Process	User	Features	Remarks
Alkalis.....	Ion exchange....	Chemical Separations Corp. Oak Ridge, Tenn.	Countercurrent continuous ion exchange in Higgins contactor is key step. Chloride-form anion resin contacts low-cost alkali such as lime, discharging chloride waste. Then, exchange with NaCl throws off hydroxyl ions to form NaOH.	Technique still in infancy. Has also produced 2.3 M KOH from NaOH and KCl

Inorganics—Continued

Product	Process	User	Features	Remarks
Alumina	Electrolysis	Lobath-Guareschi Chicago, Ill.	Pulverized silica-alumina ore is roasted, changing alumina complex to alumina. Slurrying with H_2SO_4 and subsequent steps remove metals and yield aluminum sulfate solution which is electrolized to give aluminum hydroxide. The hydroxide is calcined to give alumina.	Uses low-grade ores, acid rather than alkaline reagent.
Alumina	Extraction	.....	Laterite ore (16% silica) is calcined, then leached with caustic and treated with lime twice. First caustic-lime step removes 60–70% of silica; second removes alumina which is crystallized after conventional treatment.	Developed by U. S. Bureau of Mines, Albany, Ore.; yields 82–87%; leaves residue rich in iron oxide and titania.
Alumina	Leaching	Strategic Materials Corp. N. American Coal Corp. Niagara Falls, N. Y.	Mine wastes containing 15–25% Al_2O_3 leached with H_2SO_4 at 400 F., recovers more than 90% of available alumina.	In Strategic's Niagara Falls pilot plant, plans under way for commercial plant.
Ammonium perchlorate	Electrolysis	Pacific Engineering & Production Co. Henderson, Nev.	New electrolytic cell has nonmetallic anode that eliminates platinum anodes used in conventional electrolysis of chlorate to perchlorate. Cells show unusual chemical and electrical efficiencies.	Successful semicommercial operation since Dec. '58. To be expanded to 5 million lb./yr. capacity.
Ammonium phosphate liquid fertilizer	Formulation	Tennessee Valley Authority Wilson Dam, Ala.	Use of superphosphoric acid to supply part of phosphorus sequesters impurities in wet-process phosphoric acid and prevents precipitation when ammonia is added.	Permits use of cheaper acid in place of furnace-process phosphoric acid. TVA offers superphosphoric acid in experimental quantities.
Argon	Absorption	Linde Co. Tonawanda, N. Y.	Synthetic zeolite molecular sieves separate oxygen from argon to give high-purity gas	Commercial system uses three vertical, 20-ft.-dia. columns equipped for internal and external heating. Construction material: stainless steel.
Argon	Waste recovery	Spencer Chemical Co. Vicksburg, Miss.	Bottoms stream from natural gas oxidation step in ammonia plant is cooled to 300 F. and fractionated. Heating of argon-rich stream eliminates CO and methane as CO_2 and water. Scrubbing, followed by addition of H_2, then low-temperature separation, gives pure product.	Recovers up to 100,000 cu. ft./day argon from once-waste stream.
Barium oxide	Fluid bed reduction	Barium Reduction Co. South Charleston, W. Va.	$BaSO_4$ reduced to BaS in kiln, carbonated to $BaCO_3$, washed, mixed with 6.3% carbon, pelletized, reduced in fluid bed at 1,680 F. Process avoids formation of eutectic as in conventional arc-furnace process.	Product 97–99% pure vs. 90% for arc furnace.
Boron nitride	Nitriding	Carborundum Co. Niagara Falls, N. Y.	Mixture of boric acid and tricalcium phosphate, in water-paste form, is nitrided in an ammonia atmosphere within an electric furnace at 1,650 F. Reaction mix is leached with HCl, washed, dried, pressed.	Semicommercial stage of development. Good electrical insulator, thermal conductor, but dissolves in water.
Carbon bisulfide	Petrochemical	Stauffer Chemical Co. Delaware City, Del.	Purified methane (at 60 psig.) and liquid sulfur enter furnace held at 1,200 F. Sulfur vaporizes and mixes with methane; mixture reacts over silica gel to give conversion of 90–95% to carbon bisulfide.	New plant to go on stream in November 1960. Older unit exists at LeMoyne, Ala.
Chlorine	Electrolytic regeneration	Monsanto Chemical Co. Anniston, Ala.	Electrolysis of 33% HCl solution in filter-press-type assembly of cells (cell voltage: 2.3) yields product at cost of $36/ton. Plant cost for 20-ton/day is $400,000.	Pilot plant stage. Developed by Italian firm, Oronsio de Nora.
Chlorine	HCl electrolysis	.....	A single unit to recover Cl_2 from waste HCl consists of two cells. One produces Cl_2, the other H_2. After 48 hr., a heavy deposit of nickel forms in the first cell, while second is depleted of nickel. Roles of cells then reversed.	Process studied on lab scale by D. W. Schroeder at Seattle University. Estimated investment per daily ton is $20,000.
Diamonds, synthetic	Catalytic	General Electric Co. Schenectady, N. Y.	Process uses a molten-metal catalyst that, as a thin film between carbon and growing diamond crystal, reduces required temperature and pressure by factor of about 2. Electric current through carbon generates required heat; special cell produces pressure	Typical GE temperature is 3,000 F.; typical pressure is 1.3 million psi.
Dicalcium phosphate	Nitric acid cycle	E. S. Nossen Labs, Inc. Paterson, N.J	After acidulation of phosphate rock with HNO_3, lime addition crystallizes dicalcium phosphate. Calcium nitrate mother liquor is concentrated and thermally decomposed to solid lime and HNO_3 gas which are recycled.	Semi pilot plant trials indicate 47–53¢ unit of P_2O_5 for fertilizer-grade dicalcium phosphate
Fertilizer	Pelletizing	Chemical & Industria Corp. Cincinnati, Ohio	Rotating drum, called spherodizer, prills and pelletizes without recycle or prilling tower. Slurry is pumped to spherodizer countercurrent to hot gases from furnace. Surface drying takes place.	Installation cost runs at one-half conventional pelletizing setup.
Glass, plate	Float	Pilkington Bros., Ltd. England	Molten glass flows in 30-in.-wide ribbon over surface of liquid-metal bath, kept at required temperature zones by external heat. Yields perfect surfaces.	Firm may license process when remaining kinks are ironed out.
Hydrazine	From ammonia	Olin Mathieson Chem. Corp. Lake Charles, La.	NaOH chlorinated to sodium hypochlorite, reacted with aqueous NH_3 to form chloramine, then anhydrous NH_3 to form hydrazine, yielding higher concentration of hydrazine. Azeotropic distillation with aniline yields anhydrous hydrazine.	.....
Hydrogen	Offgas purification	Van de Mark Chemical Co. Bayway, N.J.	Indirect cooling with N_2 condenses out impurities in refinery-offgas feed. Equipment consists of battery of tubes bathed in liquid N_2. Molecular sieves and activated carbon aid removal of H_2O and hydrocarbons.	Plant makes 15 million scf./mo. with purity better than 99.99%. Investment rated at $200,000–$250,000.
Hydrogen	Purification and stabilization	Air Products, Inc. Palm Beach County, Fla.	Hydrogen gas (98.8% H_2) from Texaco partial oxidation process is purified to 99.9999% by series of coolers, dryers and absorbers. Stream then cooled and passed through ortho-to-para converter, then liquefied via Joule-Thomson expansion valve plus exchanger.	Plant, known as Air Force Plant No. 74, necessary for missile program.
Hydrogen sulfide	Hydrogenation	Freeport Sulfur Co. Moa Bay, Cuba	Hydrogen fed continuously to bath of molten sulfur produces H_2S at 800–900 F. Exothermic reaction maintains temperature.	60-ton/day plant developed by Girdler for nickel ore concentrating plant. Reported shut down in March 1960.

Inorganics—Continued

Product	Process	User	Features	Remarks
Hydrochloric acid.	One-tower plant..	Badische Anilin u. Soda Fabrik Ludwigshafen, W. Germany	Hydrogen and chlorine, burned in bell-shaped reaction chamber at base of corrosion-resistant tower, forms HCl gas that passes into packed column at top of tower. Water or dilute acid absorbs the rising gas, cools burner and tower walls.	HBr also can be manufactured in tower process.
Hydrochloric acid (anhydrous)	Solvent extraction purification	Hooker Chemical Corp. Montague, Mich.	Byproduct anhydrous HCl from chlorination of hydrocarbons, containing unreacted Cl_2 and organic contaminants, is scrubbed free of these contaminants with CCl_4, then with hexachlorobutadiene to recover CCl_4. Two-solvent system halves installation, operating and maintenance costs.	Full-scale operation at Hooker's Montague Plant
Lead silicochromate (basic)	Solid-phase.....	National Lead Co. St. Louis, Mo. Eagle-Picher Co. Joplin, Mo.	Chromic acid is added to water slurry of PbO and ground silica containing some basic lead acetate. Slurry is reacted in kiln to give product, which, on grinding, yields pigment.	Product, which consists of silica core with basic lead chromate surface, is anticorrosive paint pigment.
Lime.....	Calcining.....	Dow Chemical Co. Ludington, Mich.	Grate-type kiln uses fines; preheating the charge calcines undersize material before it enters kiln.	Developed by Allis-Chalmers. Dow plant 600-ton/day cap.
Lime.....	Sludge recovery..	Buckeye Cellulose Corp. Foley, Fla.	Sludge from water softeners in kraft pulp mill is purified by centrifugal classification, then calcined with lime mud from pulp mill causticizing circuit. Kiln discharges lime pure enough for water softening and causticizing makeup.	Process saves $5,000/mo. Eliminates waste-sludge discharge to lagoons.
Molecular sieves..	Crystallization...	Linde Co. Tonawanda, N.Y.	Sodium silicate, sodium aluminate and sodium hydroxide are mixed to form a gel, which is subsequently crystallized at 212 F. Filtration and washing, following by ion substitution and pellet formation, gives product.	Product consists of three-dimensional frameworks of SiO_4 and AlO_4 tetrahedra.
Monopersulfate bleach	.....	Du Pont Co. Niagara Falls, N.Y.	Competitive with sodium perborate for cotton and more delicate fabrics and with chlorine-containing bleach for heavy duty.	In pilot plant; large-scale unit planned for Memphis. Unlike other bleaches, product will not weaken fabrics.
Nitric acid.....	NH_3 oxidation, absorption	U. S. Steel Corp. Provo, Utah	Low pressure (40 psi.) and lower catalyst temperature (1,500 F.) give optimum conditions in new plant for maximum NH_3 conversion, minimum catalyst losses.	Developed by Montecatini, plant has 200-ton/day capacity.
Nitric acid.....	Magnesium nitrate concentration	Hercules Powder Co. Parlin, N.J.	Process shifts from sulfuric acid to magnesium nitrate as dehydrator, from packed to tray column design in nitric acid concentration. Results: Halved operating costs, 30–40% reduction in capital outlay, boosted yields, improved HNO_3 quality.	A 50-ton/day plant is in operation.
Nitrogen.....	Atmospheric fixation	McGill University Montreal, Canada	Propane burns in preheated air. 3,000 K. gases chilled quickly to fix nitric oxide at close to its equilibrium composition. 90 psia. furnace pressure gives yields up to 3.77%; 120 psia. should produce 4%.	Still very low yields compared to conventional high-pressure multipass methods.
Nitrogen dioxide..	Radiation fixation	Rensselaer Polytechnic Institute Troy, N.Y.	Under carefully selected conditions, mixtures of nitrogen and oxygen form nitrogen dioxide when subjected to ionizing radiation. At about 200 C., 235 g. of U_{308} should yield about 258 tons of nitrogen dioxide and 110 tons of nitrous oxide.	Small pilot plant installed at Brookhaven will serve as a loop to make nitrogen oxides
Ozone.....	Electric dissociation	National Bureau of Standards Washington, D.C.	Oxygen is sent through high-frequency electric discharge in a U-tube immersed in liquid nitrogen. Ozone formed by discharge condenses on tube wall and drains off.	Conversion efficiency depends on oxygen flow rate. Below 5.7 c.c./min., conversion is 100%.
Phosphate fertilizers	Calcination-hydration	Mexico Mining Development Commission Saltillo, Mexico	Process involves reduction of low-grade phosphate rock's calcium carbonate to oxide by calcination; then hydration of oxide; finally hydraulic or pneumatic separation of hydroxide.	In pilot stage, process will put end to Mexico's importation of Florida rock.
Phosphoric acid..	Tower.....	Mitsubishi Chemical Co., Mitsubishi Petrochemical and Tohuku Fertilizer Co. Akita, Japan	Produces phosphoric acid at lower cost, with simpler equipment than conventional processes. Also yields high-quality gypsum as byproduct. U. S. experts believe process may involve counter current treatment of phosphate rock to produce lean acid solution.	$139,000 plant being built.
Polyphosphates...	Spray drying-calcining	Knapsack-Griesheim AG. Germany	Ring-type burner mounted within 120-ton/day spray dryer quickly dehydrates disodium phosphate solution and converts it to powdered polyphosphate. Feed sprays right through flame.	Food Machinery's Westvaco Div. put in German-built unit of similar design at Newark, Calif.
Quartz.....	Hydrothermal crystallization	Western Electric Co.	In autoclave at 30,000 psi. and 790 F., high-quality quartz crystals are grown in caustic solution which carries silicon dioxide nutrient from another zone within vessel. Temperature differential circulates liquor.	Crystals produced on pilot scale.
Rare gases.....	Catalytic purification	M & C Nuclear, Inc. Attleboro, Mass.	Catalyst, with effective life of more than 1,000 hr., removes wide variety of solid and gaseous impurities from helium and argon at 1,200 F.	Process from American Metal Products Co. (Detroit).
Rock salt.....	Purification.....	International Salt Co. Scranton, Pa.	Selective heating by infrared of impurities in rock salt permits selective separation of rock salt from impurities. Conveyor belt coated with heat-sensitive resin retains impurities to achieve separation; these are collected on far side of belt.	U. S. Patent No. 2,907,456.
Rutile.....	From ilmenite....	Division of Industrial Chemistry Melbourne, Australia	Ilmenite reacts with sulfur vapor at 700–850 C. followed by hydrothermal oxidation of product at 100–140 C. Iron compounds removed, sulfur recovered.	Pilot plant has fluid reactor.
Silane.....	From Mg_2Si.....	Metallgesellschaft AG. Germany	Reaction of Mg_2Si with ammonium chloride at 1 atm. pressure yields 50% SiH_4 as gas. Dry ice removes NH_3, liquid N_2 liquefies SiH_4 which is further purified by distillation.	Cheaper and safer than other processes.
Silica.....	Foaming.....	Pittsburgh Corning Co. Sedalia, Mo.	In special continuous horizontal furnace, where foaming agent is added, pure silica bubbles up into tiny non-interconnecting cells; cooling sets the bubbles. Material withstands high thermal shock, has high insulating value, heat resistance and compressive strength.	Commercial plant in operation. Material is called Foamsil.

Inorganics—Continued

Product	Process	User	Features	Remarks
Silicon carbide...	Drying.....	Norton Co. Worcester, Mass.	Spray dryer cuts drying time for silicon carbide fines from three weeks to several seconds. Old process involved batch and kiln drying. New technique handles 600–750 lb./hr. (7-ft. dia. machine).	Bowen Engineering dryer is used
Sodium sulfate...	Crystallization...	West End Chemical Co. Searles Lake, Calif.	Searles Lake brine is freed of carbonate with CO_2, chilled to 59 F. and borax removed by conversion to sodium tetraborate and crystallizing same. Further cooling to 42 F. crystallizes out sodium sulfate in large crystals which are dried to anhydrous state.	400-ton/day commercial plant. Previous processes depended on evaporation.
ulfur.....	Flue-gas scrubbing	Simon Carves, Ltd. Stockport, England	Flue gases scrubbed with ammonia liquor, followed by autoclaving resultant solution. 94% of sulfur recovered in tests with effluent running 0.05 grains/cu. ft. of sulfur. Breakeven sulfur concentration in fuel: at least 1.5–2%.	Two years of large-scale pilot-plant testing have proved technical and economic feasibility. Working on two-stage scrubbing to cut ammonia losses.
Sulfur.....	Catalytic reduction	International Nickel Co. Sudbury, Ontario	Process involves sulfur recovery from smelter off-gases by catalytic reduction. Rich sulfurous gases react with a chemical reducing agent over a specially developed catalyst.	Pilot plant operation; joint project of Texas Gulf Sulfur Co. and Inco.
Sulfur.....	H_2S removal	The California Co. Perth Amboy, N.J.	Modified Claus process unit gives good sulfur recovery at low as well as high throughputs. Heart of installation is specially designed boiler-burner unit, with constant-temperature control for effluent gas.	Unit in operation; rated at 35 tons/day.
Sulfur.....	H_2S oxidation....	Pan American Petroleum Corp. Tulsa, Okla.	H_2S can be oxidized directly to sulfur over a bauxite catalyst at 370–1,000 F. For dilute H_2S streams, plant investment would be only 60% of that for a Claus process plant.	Pilot plant has operated in the field successfully.
Sulfur.....	From waste pickle liquor	Crucible Steel Co. Rust Engineering Co. Midland, Pa.	Reaction of sulfuric-acid pickle liquor with coke-oven gas yields ammonium sulfate, iron oxide, sulfur, ammonium thiocyanate, calcium ferrocyanide. Oxidation of iron sulfides (from H_2S in gas and Fe in liquor) gives oxide and sulfur	In pilot plant stage.
Sulfur.....	Recovery.....	Appleby-Frodingham Steel England	Fluid beds of iron oxide remove 99.9% H_2S and S_2 from coke-oven gas. Process supplies own heat. Air oxidizes sulfur in regenerator to SO_2 and some SO_3, suitable for contact H_2SO_4 plant.	32 million cu.ft./day plant on stream in 1959.
Sulfur.....	Recovery.....	Atlantic Refining Co.	Recovery of sulfur from refinery gases feasible via use of basic aqueous solution of a multivalent ion with a chelating agent to absorb H_2S and oxidize it to sulfur.	Process, worked out in laboratory stages, yields finely divided sulfur.
Sulfur.....	Extraction.....	.....	Sulfur-bearing ore is mixed with fuel oil, then heated above B.P. of H_2O. Slurry then contacts with second solvent pass. Addition of water separates oil plus its sulfur load from ore particles. Cooling precipitates product.	Delhi-Taylor Oil Corp. holds patent on process.
Titanium chemicals	Cold chlorination.	Armour Research Foundation Chicago, Ill.	New process, a cold chlorination of ilmenite ores, makes possible the use of lower-grade ores and crude scrap. Single starting material gives titanium metal, dioxide and the tetrachloride.	Development stage.
Vanadium halides.	Direct chlorination	Rocky Mountain Research Denver, Colo.	Direct chlorination of vanadium pentoxide yields VCl_3 which is thermally disproportionated to dichloride and tetrachloride at 300–400 C. Key to successful operation is prevention of side reactions by sweeping out VCl_4 with CO_2 as fast as it appears.	Process bypasses vanadium carbide or sulfide intermediates of older processes.
Water, desalted...	Distillation.....	American Independent Oil Co. Kuwait, Saudi Arabia Neutral Zone	Submerged combustion of natural gas provides heat for distillation of brackish or salt water. Process can operate on small amounts of feed water and scale formation problems are said to be non-existent.	Plants have been operating more than six months.
Water, desalted...	Distillation via nuclear heat	U. S. Dept. of Interior San Diego, Calif.	AEC will build a 40,000 thermal kw. pressurized-water reactor for making 5 to 175 psig. steam. Interior Dept. will build and operate 1,000,000 gpd. fresh water saline conversion plant using this steam in multistage flash distillation plant.	Reactor will cost $4 million and conversion plant $2 million. Completion expected January 1962.
Water, desalted...	Electrolysis.....	Several	Saline solution under impressed electrical potential migrates only in one direction through a special membrane.	A commercial success.
Water, desalted...	Freezing.....	Carrier Corp Syracuse, N.Y.	Brine sprays into chamber under partial vacuum at 25 F. About 15% water evaporates, leaving ice crystals and brine. After washing, crystals melt as water vapor from freezing chamber condenses on them.	New 15,000-gpd. pilot unit on stream in 1960.
Water, desalted...	Freezing.....	Cornell University Ithaca, N.Y.	Direct freezing method has isobutane refrigerant injected into tank of sea water. When isobutane vaporizes from solution, ice crystals form and are washed by countercurrent flow of water.	Office of Saline Water, U. S. Dept. of Interior, hopes for 50¢/1,000 gal. cost for freezing processes.
Water, desalted...	Freezing.....	Ministry of Economics Negev Desert, Israel	Vaporization of liquefied gas through salt water in low-pressure chamber yields salt-free ice. Details not available.	Two plants are under construction, with combined output of 500,000 gpd. at 40¢/ M gal.
Water, desalted...	Solar still.....	Battelle Memorial Institute Port Orange, Fla.	Lof still is glass, has deep basin. Unit is 2,500 sq.ft. with 250 gpd. output.	Office of Saline Water, U. S. Dept. of Interior project.
Water, desalted...	Solar still.....	Du Pont Co. Port Orange, Fla.	Du Pont stills are plastic, deep-basin units. First unit has 2,500 sq.ft. surface, 250 gpd. output; second unit has 500 sq.ft. surface, 50 gpd. Films to test: Special Mylar and variety of polyvinyl fluoride—latter may have 10–20 yr. weatherability.	Cost predicted at $1.25/1,000 gal.
Water, desalted...	Solvent extraction	Texas A & M College	Sea water contacted with solvent, water dissolves in solvent leaving brine behind. Heating separates solvent and fresh water. 200 solvents studied. Cost estimates: 50¢/1,000 gal. for sea water; 25¢/1,000 gal. for brackish water.	Experimental.
Water, desalted...	Zone freezing....	Battelle Memorial Institute Columbus, Ohio	Basic information on zone-freezing demineralization of saline water has been accumulated.	Construction of an experimental engineering model of a continuous system not started.

Metals

Product	Process	User	Features	Remarks
Alloys, ultrapure..	Controlled continuous	Firth Sterling, Inc. McKeesport, Pa.	Alloying ingredients added continuously to a strip of steel as it is rolled into a tubular electrode. Tube then arc-melted in water-cooled crucible under a slag layer, which excludes atmospheric contaminants.	"Hopkins" process developed and operated commercially by M. W. Kellogg. McKeesport capacity expected to be 800,000 lb./mo. of special alloys.
Aluminum.....	Foaming.....	Dynamic Metals Corp. Houston, Tex.	Made by mixing zirconium hydride with molten aluminum, then extruding or molding the metal. Foamed aluminum can be sawed, nailed or glued.	Commercial production within 90 days from 6 million-lb./yr. plant. Initial price: 75¢–$1/lb. Process licensed from Bjorksten Research Labs (Madison, Wis.).
Aluminum films..	Vacuum deposition	.....	Nonporous, ductile, tightly adhering films of aluminum can be deposited on steel. Film can be anodized if desired. Aluminum does not affect properties of underlying steel and resists cracking or flaking due to bending.	Developed by National Research Corp.
Cerium.....	Electrolysis.....	U. S. Bureau of Mines Reno, Nevada	High-purity cerium is made in small electrolytic cell using such fused salts as cerium chloride or cerium fluoride or oxyfluoride as electrolyte. Cell is air-tight, blanketed in atmosphere of argon and CO_2. Process takes 8 hr. to make 1 lb. cerium, cell runs at 80–85% efficiency.	In pilot plant stage with applications research on cerium under way.
Chromium.....	Refining.....	Chromalloy Corp. White Plains, N.Y.	New form of chromium, Iochrome, produced by an iodide process contains only about 10 ppb. impurities, will be used to improve high-temperature properties of metals.	Chromalloy to carry out R&D under license agreement with Chilean Nitrate Sales Corp.
Chromium plating	Separate chemical bath	Several auto manufacturers	Involves separate chemical formulations: a high-speed plating bath (over usual copper and nickel coats), followed by a "crack-free" chromium plating bath. Chromium is 10 times thicker than conventional plate.	Product of Metal & Thermit's electrochemical research lab—called Duplex Chromium More durable plate built-up to 100–200 millionths in.
Cobalt.....	Nickel seeded hydrogen reduction	Sherritt Gordon Mines Fort Saskatchewan, Alta.	Nickel-cobalt diamine sulfate solution seeded with nickel powder. Nickel plates out preferentially on addition of NH_3. Further NH_3 reduces some cobalt, causing more nickel to plate out in attempt to reach equilibrium. Co-rich solution is drawn off.	Cobalt is only 0.4% Ni instead of 1.0% Ni from conventional process.
Copper billets....	Continuous casting	American Smelting & Refining Co. Perth Amboy, N.J.	Copper billets of uncommonly large size are cast continuously in a water-cooled graphite mold that oscillates.	$4 million Asarco expansion at Perth Amboy included this facility.
Ferrochrome.....	Electroreduction..	American Chrome Co. Nye, Mont.	Electroreduction of 53% chrome ores in 5 ton/day pilot plant is designed to determine economics of producing the chromium-iron concentrate from U.S. ores rather than 65% chrome foreign ores.	.....
Gallium.....	Extraction.....	.....	Ground bauxite is treated with HCl or HBr at 700–950 C. in quartz-tube reactor to volatilize gallium in ore. Condensed gallium, dissolved in water, is precipitated with sodium hydroxide. Sodium gallate is electrolyzed to deposit metallic gallium.	Dow Chemical has applied for patents on process.
Germanium crystals	Strip growth.....	Westinghouse Electric Corp.	New method produces germanium dendrites with only one preferred direction of growth, which therefore grow rapidly into continuous strips about 1/8 in. wide, a few thousandths of an inch thick, and of almost unlimited length.	Bypasses tedious procedures of making units from wafers of conventionally grown germanium ingots.
Indium.....	Electrolytic.....	Consolidated Mining & Smelting Co. Trail, B. C.	Dross retreatment furnace slag (byproduct of lead smelting) is smelted with coke and limerock in electric furnace. Electrolytic treatment of furnace bullion gives marketable Pb-Sn alloy plus indium. Slime-leaching plus purification yields indium metal.	Product purity is 99.97%.
Iron.....	Direct reduction..	Republic Steel Co., National Lead Co. Birmingham, Ala.	Ore reduced in gas- or oil-fired kiln, 9 x 150 ft., at 1,950 F. Product contains up to 95% iron, 90% in metal form, depending on ore grade.	175-ton/day pilot plant has processed 100,000 tons ore.
Iron.....	Electric smelting..	U. S. Bureau of Mines Albany, Ore.	High-grade Montana iron ore concentrates are reduced to 99.6% iron in one-step electric smelting operation. No desilication or decarburization required before steel making.	Pilot plant technique may be useful for small mills in fuel-deficient areas.
Iron.....	High-pressure blast furnace	.....	Ultra-high pressure of 40 psi. will be used in blast furnace of totally new design to produce twice as much iron as in conventional furnaces of comparable size. Capital cost is 20–25% higher for double capacity, labor costs one-third lower.	Developed and licensed by Koppers Co., Inc., Pittsburgh, Pa.
Iron ore.....	Roasting and reduction	International Nickel Co. Copper Cliff, Ont.	Iron-rich nickel ores are roasted in fluid bed, oxidizing iron to Fe_3O_4, Ni to nickel ferrite. Kiln reduction reduces nickel to NH_3-soluble form. NH_3 leaching leaves magnetic iron which is recovered with magnets.	Plant yields nickel carbonate for processing to nickel, iron ore pellets suitable for charging to open hearth or electric furnaces.
Iron sponge.....	Direct iron reduction	Fierro Esponja, S. A. Monterrey, Mexico	Process produces sulfur-free reducing gas (85% H_2, CO_2) in high-pressure steam reformers from petroleum or, in this case, natural gas. Reducing gas acts on 105 ton iron-ore charge in each of several fixed-bed reactors. Product sponge can go directly to electric furnaces or is stored for later shipment to steel plants.	200 ton/day plant proved out; contract awarded for 500 ton/day plant.
Manganese.....	Electrolysis.....	Union Carbide Metals Co. Marietta, Ohio	Mn bearing slag from arc furnace is upgraded to 20% Mn by acid leach. pH adjusted solution goes to electrolytic cells where Mn plates out on stainless steel cathodes.	Other electrolytic Mn plants start with high grade 50% Mn ore.
Metals.....	Calcium monofluoride purification	Farben Fabriken Bayer AG Leverkusen, Germany	Calcium monofluoride, added to molten alloys and steel, copper, aluminum or titanium, reacts with metal sulfides and oxides to form calcium equivalents that concentrate in slag. After treatment, common metals and alloys show no detectable amounts of sulfur or oxygen.	.....

Metals—Continued

Product	Process	User	Features	Remarks
Metal, foamed	Foaming	General Electric Co. Flight Propulsion Lab Cincinnati, Ohio	Nickel, copper or cast iron powder may be added to mixture of organic resin and nitrogen or carbon dioxide foaming agent, then baked in oven to produce foam.	In pilot stage, foam has potential uses in jet engine seals, hot filters, insulation.
Metals, reactive	Fabrication	Universal-Cyclops Steel Corp. Bridgeville, Pa.	Argon-filled building permits processing ingots of high-temperature refractory and reactive metals into billets, bars, sheets and forgings at about 4,000 F. Space-suited operators breathe through hoses connected to outside.	Slated for completion by end of 1959.
Metals	Floating zone refining	Bell Telephone Labs Murray Hill, N. J. Sylvania Bayside, N. Y.	Bell melts specially shaped cross-sections of material to be purified—flat plates and tubes instead of usual rods. These can melt through before surface tension supporting molten zone is overcome. Sylvania increases diameter of specimen by applying electromagnetic forces to hold molten zone together.	Substantially increases amount of material that can be purified by zone refining and may extend technique to new materials. Promises refining of cross-sectional areas 5–10 times greater than conventional.
Metals	Flotation of solutes	.....	Selected soaps "chase" dissolved minerals to ocean surface when bubbles are blown through water. A small sea area would be fenced off; pipes laid on ocean bed would introduce bubbles of required soaps. Minerals would then collect on surface.	Armour & Co. (Chicago) has filed patent applications. (Called "soap and bubble" method. Developed by Prof. Felix Sebba, Witwatersrand University (South Africa).
Nickel	Electrorefining	International Nickel Co. of Canada Copper Cliff, Ont., Canada	Process takes nickel sulfide of low copper content from Bessemer converter, casts it into anodes and electrolyzes it to nickel. Elemental sulfur and selenium are byproducts	Commercial plant in operation.
Nickel	Solvent extraction	U. S. Bureau of Mines Salt Lake City, Utah	Amine extraction of HCl solution of nickel and cobalt yields nickel with less than a few ppm. of cobalt, cobalt with no chemically detectable nickel. Tri-isooctylamine has been found to be the effective extractant.	Work based on lab studies. Pilot plant facility of 1 ton/day feed proposed to produce 20 lb./day of nickel, 1 lb./day cobalt.
Rhenium	Water absorption.	Kennecott Copper Co. (Chase Brass subsidiary)	Recirculating water-spray system recovers soluble gaseous rhenium oxide from flue dust from molybdenite roasting. Ion exchange removes rhenium from solution for further processing to high-purity ammonium perrhenate.	Chase Brass marketing wrought forms of rhenium.
Rhenium	Powder metallurgy fabrication	Chase Brass & Copper Co. Waterbury, Conn.	Ammonium perrhenate, reduced by hydrogen, yields rhenium powder which is compacted at 25,000–30,000 psi., presintered for 2 hr. at 1,200 C. and ½–1 micron and finally sintered in H_2 atmosphere at 2,000 C. until bar reaches 90–96% of theoretical density.	Tested in 100 lb./yr. experiment.
Silicon, ultra-pure	.....	Du Pont Co.	Process developed by ITT affiliate Standard Telecommunication Laboratories, Ltd., involves decomposition of substantially pure silane.	Licensed. Product surpasses purity of any commercially available silicon
Smelting of ores	Strategic-Udy smelter	Quebec South Shore Steel Corp. Varennes, Que.	Limestone, ore, coal fed to kiln; burning coal supplies heat, reduces ore; kiln material fed to electric furnace where resistance of slag supplies heat to melt iron.	Kiln replaces conventional height in blast furnaces; permits use of coal instead of high-strength metallurgical coke. Makes semi-steel directly from low grade ores.
Steel	Degassing	Dortmund Horder Hutteunion, Crucible Steel, National Forge	Degassing vessel resembles giant Silex coffeemaker. Vacuum created in a chamber above ladle of molten steel pulls metal up through pipe into chamber, where violent degassing occurs for 30 sec. About 20–30 dips degasses melt.	Installation of equipment handled by Lectromelt's Vacuum Furnace Div.
Steel	HyL	Hojalata y Lamina Monterrey, Mexico	Process consists of batch reduction of lump iron ore by reformed natural gas. After reduction to sponge, reactor charge dumps to hopper for transfer to electric furnace where mixing with scrap and subsequent refining yields finished steel.	Process also scheduled for Premium Iron Ores, Canada.
Steel, strip	Two-step reduction	Republic Steel Corp.	Iron ore is reduced. Resulting metal funnels between four rolls where it is compressed to semi-steel strip. Strip passes through reducing atmosphere in furnace at 2,200 F., then is hot-rolled to desired gage and density.	Eliminates melting and smelting steps between concentrate and strip. Pilot plant under construction
Steel	Rotating furnace	Stora Kopparsbergs Borglags AB Sweden	Process treats molten pig iron with oxygen in a variable-speed rotating furnace. Claimed to cost 50–65% less than new open hearth plant of same capacity and to give ingot yields of over 91%.	Process available in U. S. and Canada through Dravo Corp.
Steel, plated	Thermal plating	.....	Steel sheet is suspended in NH_4Cl flux at 300 C. A few drops of molten lead dropped on sheet plate out instantaneously, covering both sides. Key is that supercooling occurs and this weakens attraction forces between metal atoms.	Inventor Prof. R. Takahashi of Chiba (Japan) Institute of Technology has applied for world-wide patents.
Tantalum, columbium	Liquid-liquid extraction	Fansteel Metallurgical Corp. Muskogee, Okla.	Bureau of Mines liquid-liquid extraction process will take over job of separating tantalum and columbium now done by fractional crystallization	Pilot plant studies have been carried out at Fansteel's North Chicago plant.
Thorium and uranium	Dry or wet	Davison Chemical Co. Erwin, Tenn.	Natural or low-enriched uranium metal from UF_6. Also hexafluoride converted to dioxide by the ammonium diuranate process.	First completely integrated plant to produce commercial nuclear fuels, recovered fabricator's scrap.
Thorium	Modified Kroll	U. S. Bureau of Mines Albany, Ore.	Chlorination of thorium oxalate with carbon tetrachloride yields crude thorium tetrachloride, later purified by vacuum distillation. Reaction with sodium, followed by cleanup, gives thorium sponge.	Operation now turning out 50-lb. batches. Materials of construction are problem.
Titanium (ductile)	Electrolytic	Norton Co.	Specially designed cell using titanium carbide as anode, and operating at 900 C. under argon atmosphere, produces dendritic crystals of titanium that are 99.6% pure.	Pilot cell makes 12-lb. batches. Power per lb. product is 8–10 kwh.

Metals—Continued

Product	Process	User	Features	Remarks
Tungsten, forgeable	Vacuum sintering.	Firth Sterling, Inc. Pittsburgh, Pa.	Powder metallurgy processing yields tungsten metal of 99.9% purity, with densities exceeding 90% theoretical.	Vacuum-sintered tungsten forms can be forged at 3,400-3,500 F. and shaped to relatively close tolerances.
Vanadium.....	Ion exchange.....	Dow Chemical Co. Pittsburg, Calif.	Vanadium is adsorbed on ion exchange resin along with uranium from 30% phosphoric acid made from phosphate rock. Uranium is eluted with dilute sodium chloride solution. Vanadium is then reduced with SO_2 and desorbed with water.	Operated as 1,000gpd. pilot plant for uranium recovery with an 80 to 90% vandadium recovery.
Zinc foil.....	Electrolytic	American Smelting & Refining Co. South Plainfield, N. J.	Zinc is deposited electrolytically from zinc sulfate bath onto revolving drum from which it is stripped in continuous sheet up to 26-in. wide, 0.001–0.005 in. thick. High chemical purity product said to have unique ductility and tensile strength.	Larger pilot plant production planned for Corpus Christi, Tex. plant. More economical than rolling.

Nuclear Materials & Technology

Product	Process	User	Features	Remarks
Ceramic nuclear fuels	Powder metallurgy	Atomic Energy Commission, Hanford Works Richland, Wash.	Uranium dioxide powder plus binding lubricant is cast in 50-ton press to yield bracelet-like elements. Further pressing at 50,000 psi. followed by sintering at 3,200 F. gives product.	Can withstand reactor temperatures to 5,000 F.
Fission gasses....	Dynamic adsorption	Oak Ridge National Lab Oak Ridge, Tenn.	Contamination of the atmosphere can be controlled by a disposal system based on adsorption of gases by porous solids, such as activated charcoal.	Successfully operating on a 5 megawatt homogeneous nuclear reactor at Oak Ridge.
Fusion.....	Intermediate current stability experiment (ICSE)	Great Britain Near Harwell	Large discharge tube will reduce time for discharging extremely large plasma-producing pulses of electricity, from a few milliseconds to a few microseconds. Doughnut-shaped like Zeta, ICSE will employ "pinch" effect, but will have more complex magnetic system to improve stability and eliminate losses.	Planning stage. Scheduled for completion in 2–3 years to replace present Zeta machine eventually. Cost: estimated $1–1.4-million.
Fusion studies....	Stellerator.....	Project Matterhorn Princeton University	Heats plasma of ionized gas confined in an endless tube by external magnetic fields.	Working model shown at 2nd U. N. International Conference on Uses of Atomic Energy.
Heavy water.....	Low-temperature distillation	L'Air Liquide Co. Toulouse, France	Synthesis gas feed is cooled to −253 C. where hydrogen and deuterium are separated by distillation. Process proved in two pilot plants, one experimental industrial plant: operating cost probably $16/lb. heavy water, capacity 40 tons/yr.	.....
Heavy water.....	Spevack dual temperature	Atomic Energy Commission Aiken, S. C. Dana, Ill.	Deuterium in water undergoes enrichment by transfer to H_2S gas at high temperature and back to water at low temperature. Flow and equipment improvements over predecessor process shrink operating costs by reducing energy consumption.	Covered by patent U.S. 2,895,803; process has operating cost of $13/lb.
Heavy organic chemicals	Chemonuclear synthesis	Hercules Powder Wilmington, Del.	Enriched UO_2 powder feeds into a fast-moving stream of organic vapor. Fission fragments knock hydrogen atom from methyl group to form free radicals. Methanol yields ethylene glycol, for example.	Conceptual design. 100,000,000 lb./yr. plant forseen. AEC evaluating for nitrogen fixation.
Nuclear electricity	Plasma thermocouple	Atomic Energy Commission Los Alamos, N. M.	Uranium rod, suspended in tube filled with cesium vapor, is lowered into critical core of reactor. Rod fissions, thermally stripping electrons from cesium. With 3.8v. between components, 38–40 amp. current flows.	At 17% efficiency, delivered 130 w.d.c. to light lamp for 12 hr. in test.
Nuclear energy...	Boiling-water reactor	JENER (Gov't. Agency) Halden, Norway	Classed as an experimental project, reactor produces no power. Thermal output converted to pulpmill steam. Fueled with natural uranium, unit is moderated with heavy water.	Rated thermal output of $3.7-million unit is 10,000 kw. Plans call for higher output soon.
Nuclear fission...	Liquid fluid-bed reactor	Martin Co., Nuclear Div.	Pellets of slightly enriched U-238 are fluidized by upflowing liquid moderator. When pellets are just sufficiently separated, chain reaction occurs. Reaction decreases if flow is reduced, causing pellets to fall back in unfluidized heap.	Preliminary studies made; critics experiment will be conducted to make small amount of power.
Nuclear fuel elements	Tungsten coating.	Battelle Memorial Institute Columbus, Ohio	Coating of uranium dioxide powders with metallic tungsten permits fabrication of improved nuclear fuel elements, for slurry or fluidized-bed reactors.	Bench scale.
Nuclear fuel reprocessing	Fluoride process..	Argonne and Oak Ridge labs	ORNL bubbles elemental F through molten salt of ZrF_4 UF_4 above 525 C. Argonne fluorinates metallic U with BrF_3 at 120 C. and 3 atm. to produce UF_6.	Pilot plant.
Nuclear fuel reprocessing	Solvent extraction	Du Pont Co. Savannah River, S. C.	Modified version of Purex process called Dual-Temperature Purex process separates fission products from uranium and plutonium in one solvent extraction cycle. Using tri-n-butyl phosphate.	Laboratory scale.
Nuclear waste....	Calcination.....	National Reactor Testing Station Idaho Falls, Idaho	Developed jointly by Argonne National Laboratory, Phillips Petroleum and Fluor, process reduces high-level radioactive liquid wastes to safer, more storable solids occupying one-seventh the space.	Pilot tests completed, Fluor gets $3.4-million contract to build calcination system at Idaho Falls.
Radioisotopes....	Recovery.....	Oak Ridge National Lab Oak Ridge, Tenn.	Waste nitric acid feed (from fuel reprocessing) is evaporated prior to separation steps. Stepwise adjustment of pH and other conditions separates ruthenium, strontium, cerium, promethium and technetium. Standard techniques purify these fractions.	New $3-million plant designed to recover radioisotopes from 500 gal./day of waste HNO_3.

Nuclear Technology—Continued

Product	Process	User	Features	Remarks
Radioactive waste storage	Salt cavities.....	Atomic Energy Commission Hutchinson, Kan.	Mined-out salt deposit is being used in tests to learn if radioactive wastes can be stored safely in such cavities. Test site is 650 ft. underground, equipped with measuring and recording devices.	Research project with simulated liquids is being carried out jointly by Oak Ridge, AEC and Carey Salt Co. in Hutchinson, Kan.
Radioactive waste disposal	Fusion.....	Atomic Energy of Canada, Ltd. Chalk River, Ont.	Liquid radioactive waste is added to a mixture of 85% nepheline syenite and 15% lime. Heating to 1,350 C. causes vitrification to a glass which can then be buried.	Leaching tests being conducted look favorable.
Thermoelectric power generation	Radioactive decay	Atomic Energy Commission	Lead telluride doped with traces of bismuth or manganese is material for thermocouples that are arranged in spoke pattern around core of polonium-210. Thermocouples capture heat of decay and convert it to electricity at 8–10% efficiency and initial 5-w. power.	Unit designated SNAP III by Atomic Energy Commission. Developed by Minnesota Mining as subcontractor to Martin Co.
Uranium.....	Electrolytic reduction	Atomic Fuels Corp. Tokai-Mura, Japan	Pure uranyl chloride solution produced by a Higgins reactor enters an electrolytic reducer's cathode chamber, a filter-press type bank of 12 diaphragm cells. Dialytic reduction yields tetrachloride solution.	Japanese government proving out process on semiworks scale, seeking less capital investment per unit output.
Uranium.....	Nonaqueous.....	Brookhaven National Lab Upton, N.Y.	New method to recover uranium from zirconium-tin alloy in nuclear fuel elements produces volatile uranium hexafluoride in a halogen fluoride solution. Uranium salt is then separated by distillation.	Pilot plant under construction.
Uranium.....	From lignite.....	International Resources Corp. Custer, S.D.	Fluid-bed roasting of lignite, followed by quenching, grinding, acid leaching of ash, yields liquor which is solvent-extracted to recover original 0.225% U content of lignite.	Company has $6-million AEC contract for mill, expects to break even.
Uranium.....	Centrifugal extraction	Texas-Zinc Minerals Corp. Mexican Hat, Utah	Mill uses high-speed centrifugals, instead of gravity mixer-settlers, in its solvent extraction step. Reduces solvent inventory by 20-fold. A 15-sec. pass yields 0.8 gph. U_3O_8 to 80 gpm. organic solvent.	First such installation in industry.
Uranium.....	Solvent extraction	U. S. Phosphoric Products Co. Tampa, Fla.	Capryl pyrophosphate ester at 80–90 F. extracts uranium content (0.01–0.02%) from wet-process phosphoric acid. HF precipitates green salt from pregnant solvent. Centrifugation yields products.	Method overcomes impurity-stabilization of acid-solvent emulsions.
Uranium hexafluoride	Three-step continuous	Union Carbide Nuclear Co. Paducah, Ky.	Process converts uranium tri-oxide from solvent extraction of virgin-ore concentrates, to the dioxide by hydrogen reduction. Hydrofluorination of dioxide yields UF_4, which converts to the hexafluoride on fluorination.	All reactions require close instrument control. Requires handling of HF (moist) at 1,000 F.
Uranium ore.....	Leaching.....	American Milling Corp. New Mexico	Ammonium chloride and H_2O_2 are injected into underground ore formation to leach out ore.	Experimental.
Uranium oxide...	Moving-bed ion exchange	Lucky Mc Uranium Corp. Gas Hills, Wyoming	Resin moves between adsorption and elution sections. Other flows stay within related sections, avoiding accidental mixing of pregnant liquor with backwash, eluate or acid wash. Two sets of three series-connected columns.	Costs 15% less than fixed-bed ion exchange systems.
Uranium oxide...	Resin-in-pulp....	Mines Development, Inc. Edgemont, S.D.	After acid leaching of ore, uranium is extracted by RIP exchange with anion resins. Sulfate elution, substituted for conventional nitrate elution, recovers uranium from loaded resins for first concentration.	Sulfate elution conserves water, prevents tailing solution stream pollution and increases oxide concentration in yellow cake.
Uranium tetrafluoride	Continuous via uraniumoxalate	Deutsche Gold-und-Silber Scheidenanstalt Frankfurt, Germany	Wet uranium oxalate is treated in rotary kiln to 550 C. under hydrogen atmosphere. After all steam and CO_2 are removed, HF containing 25% H_2 passes through kiln. Second kiln, similarly operated, uses exit gases from first, boosts HF use to 80% of input.	Kilns produce water-free tetrafluoride in 100% yield based on oxalate.

CE's Processes & Technology Reviews . . .

This ninth inventory lists 349 major process and technology advances that were announced in periodical literature or made important news during the 24-month period ending February 1960. This list includes only developments that have been made public and have reached an advanced stage of development.

For projects not included in the present tabulation see earlier appearances of this feature initiated by CE in 1951. These include the following issues: February 1951, 1952, 1953; January 1954; Inventory Issues 1954, 1955, 1956; and the regular issue of May 5, 1958.

In most cases few details have been published on these developments, so for more information we suggest contacting firms listed as having developed or using these techniques.

Nuclear Technology—Continued

Product	Process	User	Features	Remarks
Uranium tetrafluoride	From ammonium diuranate	Spanish Board of Nuclear Energy	Ammonium diuranate reacts with vaporized NH_4F.	Gets around need for using corrosive and hazardous HF.
Uranium tetrafluoride	Absorption recovery	Union Carbide Nuclear Co. Paducah, Ky.	Absorption in a fluidized bed of UF_4 when standard methods could not be used.	Plant scale fluidized-bed absorber installed July 1958.
Uranium, thorium	Solvent extraction	Davison Chemical Co. Erwin, Tenn.	Uranium hexafluoride is converted to UF_4 with hydrogen, then is reacted with steam to give oxide or with magnesium to give metal. Pulse-column solvent extraction is used in uranium/thorium purification.	$2-million plant produces 500 lb./day thorium metal, 1,000 lb./day thorium oxide, 2,000 lb./day uranium metal.
Uranium-vanadium	Solvent extraction	Vanadium Corp. of America Durango, Colo.	Mixed aliphatic amine-alkylphosphate extractants recover uranium and vanadium from acid leaching liquor for recycle to carbonate leach system that yields yellow cake and vanadium filtrate.	Extraction technique originally developed by U. S. Bureau of Mines, Salt Lake City, Utah.

Petroleum & Natural Gas Products

Product	Process	User	Features	Remarks
Crude oil	Extraction		Oil sands of the Athabasca River in northern Alberta, Canada, are mined by efficient German-developed "mining wheel" which can handle 9,600 cu.yd./day.	Pilot operation sponsored by Imperial Oil, Cities Service, Richfield Oil and Royalite Oil.
Ethylene	Thermal cracking.	Erdoelchemie GmbH Dormagen, Germany	Feature of new process is noncatalytic cracking, using sand as a circulating heat-transfer medium. Versatile with respect to feedstocks and operation.	Capacity is 20,000 tons/yr. ethylene, or total of 35,000 tons/yr. C_2-C_4 olefins.
Fuel gas	Hydrogasification of shale	Institute of Gas Technology Chicago, Ill.	Crushed oil-bearing shale is reacted with hydrogen at about 1,200 F. and 2,000 psi. to produce fuel gas with 800 Btu./cu.ft. heating value for estimated cost of 37½¢/million Btu.	Now possible technically, process may be feasible economically in future.
Gasoline	Acid treating		Removal of nitrogen and other catalyst poisons from cat cracker charge stock by treating with spent alkylation acid or 35–40% H_2SO_4 results in better gasoline yields from cracking unit.	Developed by Petrolite Corp., available for licensing.
Gasoline	Two-stage cracking	Shell Oil Co. Anacortes, Wash.	Two-stage cracking ups octane rating, yield. Major equipment includes a riser reactor, dense-bed reactor, two fractionators, catalyst stripper & regenerator.	Charge rates of 13,000–30,000 bbl./day and total conversions of 65–90%.
Gasoline	Ethylene oxide sweetening	LaGloria Oil & Gas Co. Tyler, Tex.	Treatment of gasoline with ethylene oxide removes mercaptans. Mercaptan hydrogen links with oxygen of the oxide, making an alcohol with a sulfide linkage in the middle.	U. S. Patent No. 2,862,804 issued to C. O. Petty.
Gasoline	HF alkylation	Skelly Oil Co.	Depropanizer located ahead of deisobutaniser reduces corrosion. Shell-and-tube reactors operate with only 5 F. water-temperature rise through tubes.	Commercial.
Gasoline	Isocracking	Standard Oil of Calif. Richmond, Calif.	Hydrocracking process converts marginal stocks into unusually high-octane gasoline at mild temperatures (500–700 F.) and with volume yields over 100%. Key to features is a "rugged new catalyst."	Tested in commercial plant; estimated payout time for $350–450/bbl. investment is 2 yr.
Gasoline	Polymerization of olefins	California Research Corp. Richmond, Calif.	Liquid phosphoric acid catalyst overcomes limitations of fixed-bed conventional catalyst in polymerizing C_3-C_4 olefins for high-octane blending stock. Requires Hastelloy B equipment but gives higher output, conversion.	100-bbl./day demonstration plant; offered for license.
Gasoline	Sweetening	Sun Oil Co.	Iron-containing bauxite promotes air oxidation of mercaptans to disulfides at temperatures of 70 to 170 F. at a cost of 0.6 to 1¢/bbl.	Pilot plant.
Gasoline	Unicracking	Union Oil Co.	Process involves catalytic cracking of low-quality distillate fuels in presence of hydrogen. Catalyst is regenerated intermittently, and retains its activity for a number of months.	Process announced late 1959; details withheld.
Gasoline "bricks".	Emulsion	Institute of Fuels, USSR Academy of Sciences	Solid emulsion consisting of 95% gasoline trapped in honeycomb-like cells is formed by mechanical and ultrasonic agitation of feed mixture. Feed components include a distilled-water solution of ammonium chloride, casein, polyvinyl chloride, glycerine, gasoline, formaldehyde and oxalic acid.	Bricks transformed back to liquid by squeezing machine. Gasoline losses less than 3%. Used on IGY expedition to Antarctica.
Gasoline, high octane	Adsorption		Molecular sieves separate normal paraffins from branched-chain and cyclic hydrocarbons in upgrading gasoline stocks. In isomerization, sieves remove paraffins from pentane-hexane; in alkylation, normal butane from isobutane.	Developed by Linde Co.
Gasoline, high octane	Isomerization		C_5-C_6 naphtha feed is purified, then isomerized in the liquid phase at "very low 80–120 F. temperature," made possible by the use of "extremely active" catalyst. Low temperature permits high once-through conversion.	Under pilot development by Esso Research & Engineering, Esso Standard Oil and Humble Oil Cos.
Gasoline, distillate fuels	Catalytic hydrodesulfurization	Kerr-McGee Oil Industries Wynnewood, Okla.	Process, using cobalt-molybdenum catalyst, can operate on a variety of feedstocks to improve product quality. A particularly interesting result is the removal of metals from heavily contaminated gas oils.	Unit in operation late 1958.
Heavy gas oil	Deasphaltizing	Humble Oil & Refining Co. Baytown, Tex.	To get optimum utilization of crude oil residuals, residual is fed to the middle of an extraction tower where wash oil is injected near top, light hydrocarbon near bottom.	Commercial unit being installed. Gives reduced metals content, better and more feedstock for catalytic cracking.

Petroleum & Natural Gas—Continued

Product	Process	User	Features	Remarks
Isopentane	Penex	Phillips Petroleum Co. Borger, Tex.	Pentane fractions are catalytically isomerized in presence of hydrogen to yield isopentane. Operating conditions of 700–900 F. at 200 psi. give efficiencies of 99% at conversion levels above 50%.	Developed by Universal Oil Products, process has proved itself in year's operation. Yield: 16,000 bbl./day.
Isobutane	Butane isomerization	Shell Oil Co. Wilmington, Calif.	New reactor in Shell liquid-phase isomerization eliminates back-mixing, achieves close to plug flow. Conversion is increased from 51% to 60% per pass, capital investment (for new plant) lowered by 15%.	.....
Isobutane	Platinum catalysis	Standard Oil of Calif. Richmond, Calif.	New catalyst allows operation at lower temperatures, which favors a higher equilibrium ratio of isobutane to n-butane.	Universal Oil Products, new Pt-containing catalyst boosts capacity.
Jet fuels	Hydrogenation	Standard Oil Co. (Ind.) Whiting, Ind.	Aromatics from cat reforming bottoms or cycle oil from cat cracking can be hydrogenated to alkyl naphthalenes best suited for high-performance jet fuels.	As much as 2% of total crude run can be converted to jet fuel.
Methane	Hydrogenation of oil	British Gas Council Solihull, England	Heavy oil sprays into the base of a fluidized bed of powdered coke which has hydrogen streaming through it. Coke recycles to prevent agglomeration. Methane taken off top of hydrogenator and purified.	1 million-cu. ft./day plant on stream. Costs are competitive with conventional gas manufacturing.
Natural gas	Dehydrating and sweetening	.....	Molecular sieves can provide twice the dehydration capacity while giving longer life. For sweetening, good results are obtained with single-stage rapid-cycle unit.	Said to be competitive with conventional systems.
Oil from tar sands	Atomic bomb	.....	Two-kiloton atomic blasts and 10-kiloton hydrogen blasts could be used to free crude oil from Athabasca (Canada) tar sands, est. at 300 billion bbl. of oil.	Project is under study by U. S. Government and Richfield.
Olefins	Absorption	Farbwerke Hoechst AG Germany	Scrubbing with $AgBF_4$ solution removes olefins from mixture of cracked gases. Ag absorbs olefins leaving CO, CO_2, N_2 and H_2 behind. Heating salt solution drives off olefins.	Losses of Ag solution negligible.
Olefins, ethylene, acetylene	Pyrolysis	Farbwerke Hoechst AG Frankfurt-Hoechst, W. Germany	Special burner combusts gaseous or liquid fuels in oxygen. Naphtha feedstocks injected into hot combustion gases react to produce acetylene-to-ethylene ratios varying from 80:20 to less than 30:70. Acetylene solvent extracted, ethylene removed by a low-temperature process.	100 million-lb./yr. plant under way. Yield of ethylene and acetylene runs 50–54% by wt. with widely varying product ratios.
Paraffins, normal	Molecular sieve separation	Universal Oil Products Co. Des Plaines, Ill.	Normal paraffins are removed from hydrocarbon mixtures by continuous molecular sieve process.	Trade-named Molex.
Petroleum distillates	Nalfining	.....	Light fractions, after contacting acetic anhydride, are given a caustic bath to remove reaction products. Acetates, sulfur, nitrogen and oxygen products remain oil soluble and innocuous.	Process, licensed by Nalco Chemical Co., has been commercially tested at two Southwest refineries.
Petroleum feedstock	Electrostatic desulfurization	Several	Naphtha feed, mixed with H_2SO_4, enters reactor equipped with electrodes. Here electrical energy imparts violent and rapid energy to dispersed particles. Neutralization with caustic, followed by water wash, yields desulfurized product.	Developed by Howe-Baker Engineers, Inc., Tyler, Tex., process can remove 95% of sulfur.
Pipeline gas	Glammarco-Vetro-coke	Transwestern Pipeline Co. Fort Stockton, Tex.	Sodium and potassium carbonate solutions, containing tri- and pentavalent arsenic, remove H_2S. Typical additives for removing CO_2 are arsenic oxide, and selenious and tellurous acids. Cost is half that of amine process, power is one-eighth.	First U. S. plant will reduce CO_2 content of natural gas from 28% to 2% and H_2S from 0.2% to nil. Daily flow of 180 MMcf. at 1,050 psig.
Synthesis gas	Lignite gasification	U. S. Bureau of Mines Grand Forks, N.D.	Lurgi-type fixed-bed reactor has lignite fed from above to bed where it is reacted at 25–30 atm., temperatures as high as 2,600 F., with steam and oxygen. Unlike conventional Lurgi process, reactor slag-discharging device (primarily water quench and slaglock) permits operation at temperature above fusion point.	Tested on pilot plant scale. Process increases capacity, thermal efficiency; reduces steam consumption.

Plastics, Resins & Rubber

Product	Process	User	Features	Remarks
Butyl rubber	Sulfurless curing	All major tire makers	New vulcanizing process uses phenolformaldehyde derivatives, produces a butyl rubber that resists sustained temperatures to 400 F. or 700 F. for short times.	Under research by U. S. Rubbe
Epoxy resins	Coating	Union Carbide Plastics Co. New York, N.Y.	Epoxy coating formulations which cure rapidly at room temperature are applied with special self-cleaning spray gun which mixes resin with hardener.	Spray gun made by A. Gusmer, Inc., uses hydraulic driving pressure, reducing overspray.
Fluorinated hydrocarbon rubber	Copolymerization	Du Pont Co. Deepwater, N.J.	Copolymerization of vinylidene chloride and hexafluoropropylene yields rubber which resists oils and solvents as well as temperatures in the 400–600 F. range.	Will compete with Kel-F, Teflon rubbers, silicones.
Graft polymers	Mechanical	Army Ordnance Corps Rock Island Arsenal, Ill.	Technique involves milling (roll mill) of a sodium dispersion with the polymer, then addition of the monomer, and finally the alcohol.	Process has successfully lab-grafted styrene and acrylonitrile onto polybutadiene and nitrile rubbers.
Isoprene	Synthesis	.....	Reaction of propylene and ethylene over an organometallic catalyst at 390 F. and 725 psi., followed by catalytic dehydration, yields product isoprene.	Developed by Toso Amenlya of Japan's Resources Research Institute.
Methacrylic and acrylic derivatives	Oxidation	Escambia Chemical Co.	Oxidation of isobutylene with nitrogen tetroxide is potentially important for making methacrylics. Oxidation of polypropylene with nitrogen tetroxide aims at acrylic derivatives.	Patented.

Plastics, Resins & Rubber—Continued

Product	Process	User	Features	Remarks
Nitrile silicone rubber	Polymerization	General Electric Co. Waterford, N.Y.	Extremely pure nitrile intermediate is converted into a fluid by hydrolysis and then into a very high-molecular-weight polymer. Polymer is converted to rubber by conventional techniques.	Commercial. Resists oils, fuels and solvents, temperatures from 100 to 500 F.
Phenolic resin, unmodified	Catalytic process	Reichhold Chemicals, Inc. White Plains, N.Y.	An unidentified process technique and catalyst system produces an unmodified phenolic resin for low- and high-pressure laminates that withstands 4,500 F. for short periods, 500 F. for over 100 hr.	Reichhold building commercial plant.
Plastics, porous	Swelling	ESB-Reeves Corp. Buena Vista, Va.	Starch and virtually any thermoplastic are mixed and shaped. Shaped material is boiled in water. Each starch particle gels, expanding by 40% to rupture its cell wall. Sulfuric acid leaches out gel, leaving a myriad of tiny pores in the plastic.	PVC porous plastic in production. Rice starch gives 1–5 micron pores, corn 5–10, potato 20–30 etc.
Polybutene-1	Catalytic	.....	Process polymerizes purified butene-1, then separates polymer with furfural in absorbers and strippers. Catalyst is described as "complex."	Pilot-plant is planned by Petro-Tex Chemical in Houston, Tex.
Polybutadiene	Butadiene polymerization	Firestone Tire & Rubber Co. Orange, Tex.	Called Diene, polybutadiene rubber is polymerized over a lithium-derivative catalyst. Product's structure differs from polybutadiene made over Ziegler-type catalysts.	30,000-ton/yr. plant under construction at Orange, Tex.
Polyethylene	Low-pressure	R. Mihail, Roumanian Institute for Chemistry, Bucharest	Ethylene passed into polyethylene melt at 140 C. and 40 atm. to produce polymer with molecular weight of 40,000. Melt contains chromium oxide catalyst (on a silica-alumina carrier) activated by lithium alanate.	Requires no diluent (eg., pentane or octane) for reaction.
Polyethylene, linear	Soluble catalysis	Hercules Powder Co. Wilmington, Del.	Highly linear polyethylene with outstanding impact and tensile strength is synthesized by using catalysts such as tetraphenyl tin, aluminum chloride and vanadium chloride which are soluble in reaction medium.	In development stage.
Polyisoprene	Batch polymerization	Goodyear Tire & Rubber Co. Akron, Ohio	This man-made "natural rubber" is polymerized from isoprene monomer in a hydrocarbon solvent using Ziegler-type of lithium-derived catalyst.	Produced in 500-gal. pilot-plant reactors.
Polymethylene	Catalytic polymerization	.....	A Ziegler-type organo-metallic catalyst that is soluble in hydrocarbons produces polymethylene. Tetraphenyl tin, aluminum chloride and a vanadium salt trigger polymerization of ethylene gas at 40–80 C. and 50 psig.	Under lab study at Union Carbide Plastics (Bakelite).
Polyolefins, oriented	Ziegler type	Goodrich-Gulf Chemicals, Inc. Port Neches, Tex.	Produces ethylene polymers of high-density type not presently available in U. S. for use in bottle, pipe, wire and cable applications.	Plant will have initial capacity of 13 million lb./yr., scheduled for completion late in 1960.
Polystyrene film	.....	Dow Chemical Co. Cleveland, Ohio	Until now, thin-gage film hard to make economically from polystyrene. Dow will make 1, 1.25, 1.5 and 2 mil gages at prices competitive with cellophane.	Commercial.
Polyvinyl alcohol resin and fiber	Japanese process	Air Reduction Co. Calvert City, Ky.	Developed by Japanese firm Kurashiki Rayon Co., process makes polyvinyl alcohol by indirect hydrolysis of polyvinyl acetate with an alcohol such as methanol or ethanol. PVA resin is basic component of Vinylon fiber.	Airco is building $12 million, 20 million-lb./yr. plant to use process licensed from Japanese.
Rubber, synthetic	Copolymerization	Du Pont Co. Deepwater Point, N.J.	Copolymerization of vinylidene fluoride and hexafluoropropylene produces synthetic rubber with high chemical and thermal stability.	Material called Viton is produced commercially.
Urethane foam	Foamed-in-place	Pittsburgh Plate Glass Co. Pittsburgh, Pa.	Similar to other rigid urethane foams but has low 0.11–0.13 "k" factor because blowing agent is halogenated hydrocarbon such as Freon, Genetron or Isotron.	Insulation effect from 1¼-in. thickness equals 3 in. of conventional CO_2-blown foam.
Vinyl resins	Foaming	B. F. Goodrich Corp.	Activated sodium borohydride is added to plastisol as a blowing agent. Foam control comes from pretreatment of borohydride and choice of activator.	.....

Pulp & Paper

Product	Process	User	Features	Remarks
Groundwood pulp	Drying	John Breakey, Ltd. Quebec	Pulp flows through a double-disk fluffer which acts as first drying stage. After separating in a cyclone, pulp enters stream of hot gases and enters two Glomera flash dryers in series.	Commercial; drying process retains all pulp characteristics.
Groundwood pulp	Drying	Halifax Power & Pulp Sheet Harbour, N. S.	Groundwood dewaters mechanically, is fluffed in a disk refiner, dryed in a rotary dryer and baled. Reduced water content saves on shipping and storage costs.	Called the Bauer-Bale system.
Newsprint	From cold caustic pulp	Coosa River Newsprint Co. Coosa Pines, Ala.	Low-grade hardwoods and bagasse can be converted to newsprint through modified cold caustic soda pulping. Developed by Forest Products Laboratory.	Commercial.
Paper, waste	Asphalt dispersing	Federal Paper Board Co. Steubenville, Ohio	Asphalt on waste paper is completely dispersed into pulp by passing through a Hydrapulper, ragger, junk remover, liquid cyclones and Pandia continuous digester.	Developed by Black-Clawson.
Paper coating	Trailing-blade coater	Crocker, Burbank & Co. Fitchburg, Mass.	Twin-blade coater produces coated book stock ranging from 30-50 lb. cover stock at speeds up to 2,000 fpm.	Commercial.
Paper, electrical insulation	Cyanoethylation	Hollingsworth & Vose Co. East Walpole, Mass.	Carried out on kraft pulp in rotary boilers; acrylonitrile added slowly with good agitation. Degree of cyanoethyl substitution varies with acrylo-to-pulp ratio and reaction time to give 0.3–2.8% nitrogen in product.	Developed by GE, process gives Permalex kraft paper insulation with resistance to thermal degradation of electrical properties.

Pulp & Paper—Continued

Product	Process	User	Features	Remarks
Paper, extensible	Clupak shrink process	W. Va. Pulp & Paper Co. Charleston, S. C.	Process builds stretch into paper by compressing it lengthwise and, to some extent, cross-wise with a rubber roll.	Paper tougher than ordinary paper, effect similar to creping.
Pulp	Cold soda	Pandia Division, Black-Clawson Co. New York, N. Y.	Using screw press, reactor, pulp treater, disk refiner, pressure screens and filter washers without steam or hydraulic pressure, pulping system makes completely defibered pulps with only 10 hp./day/ton.	.....
Pulp	Continuous digestion	Hammermill Paper Co. Erie, Pa.	Upflow principle used in new digester gives it advantage of inherent thermal stability. Perforated piston inside digester bottom periodically advances chip mass upward through vessel.	Commercial. Digester developed by Improved Machinery, Inc.
Pulp	Magnefite	Howard Smith Paper Mills Cornwall, Ont.	Magnefite process uses higher combined SO_2 concentration in magnesium bisulfite solution without normal excess SO_2, eliminating pressure problem. Liquor made at 60–70 C., also stored at temperatures close to b.p. Cooking time is 5 hr.	Experimental; pulp is superior to regular sulfite pulp.
Pulp	Modified bisulfite (Arbiso)	Abitibi Power & Paper Co.	Pulping is based solely on $NaHSO_3$; cooking liquor is free of SO_2, simplifying handling. Pulp strength is higher for the same wood than with an acid sulfite cook.	Claims improved mill operation and higher yields.
Pulp	Sutherland process	.....	After short cook, pulp is pulverized in disk refiners between blow tank and pulp washers.	In public domain—greater fiber yield.
Pulp	Two-stage cooking	Rauma-Repola Rauma, Finland	Sulfite pulp cooks in two stages without reducing pressure and temperature between stages. Liquor may be burned in kraft-type unit, but does not require causticizing. Either softwood or hardwood may be pulped to high quality product.	Stream pollution abatement is similar to kraft mill; gives little air pollution.
Pulp, cellulose	Continuous digestion	University of Fla. Gainesville, Fla.	Theory is that pulping reaction is independent of wood-liquor ratio. Wood chips are suspended in pipes and equipment by recycling an excess of liquor.	Pilot plant, 3 tons/day.
Pulp, dissolving	Multistage bleaching	Buckeye Cellulose Corp. Foley, Fla.	Eleven-stage bleaching process for dissolving pulp, seven stages for paper pulp. Woodpulp upgrading produces dissolving pulp for 1,100-denier yarn—formerly attainable only from cotton linters.	Regular purity of dissolving pulp is 97.5% alpha cellulose and is approaching 98% and best linters purity—for 80–90% of cost of linters pulp.
Pulp, sulfite	Sodium-based	Rayonier, Inc. Hoquiam, Wash.	Sodium-based pulping process recovers over 85% of pulping chemicals, leaving 15% of sulfite liquor residues to be disposed of—an important antipollution feature.	Rayonier converting Washington plant to new process. Will be completed in 1961 at a cost of $7.5 million.
Pulping	Rotating disk pulper	Black-Clawson Co. Berlin, N. H.	Slow-speed rotating-disk pulpe-treating machine provides powerful defibering action without loss in freeness of fiber length. Power requirements for defibering are estimated at 4 hp.-days/ton.	Tested and commercial-scale pilot plant.
Sulfite liquor	Sulfide recycle	Consolidated Water Power & Paper Co. Wisconsin Rapids, Wis.	Spent sulfite liquor from pulping process is treated with recycled sodium sulfide and sodium carbonate, producing a noncorrosive liquor handled like kraft liquor. Sodium carbonate is recovered via crystallization, sulfur is recovered from furnace gases.	In use at Consolidated's 100-ton/day pulp mill on a pilot plant basis.

Synthetic Fibers

Product	Process	User	Features	Remarks
Graphite cloth	Carbonization	National Carbon Co., Div. of Union Carbide Corp. Fostoria, Ohio	Natural or synthetic material, such as cotton or rayon, is carbonized, then converted to fibrous graphite by electrically produced heat of 5,400 F. Any textile form can be graphitized.	Semi commercial plant. Produc offered as 40 in. x 7 ft. sheeting. Experimental price: $1.50/sq. ft. Potential: plastic reinforcement, bag filters.
Nylon-6	Caprolactam polymerization	Allied Chemical Corp. Hopewell, Va.	Caprolactam monomer is formed from phenol and then polymerized to 99.94% pure nylon-6. Gold in color, the high purity polymer comes from use of special catalyst systems that up yield, reduce byproducts.	Commercial scale, 20 million-lb./yr. plant.
Potassium titanate	Fibration	Du Pont Co. Newport, Del.	In fibrous form, potassium titanate is claimed twice as effective, on a volume basis, as any known insulation in the 1,300–2,100 F. range. Product may find use in rockets, missiles, aircraft and nuclear-powered vehicles.	In early development and being made on semi-works scale.
Polyester fiber	Polymerization	Eastman Kodak Co. Kingsport, Tenn.	Fundamentally different in chemical composition and internal molecular structure from any other polyester. Has outstanding resistance to pilling, resists chemicals, heat.	Facilities installed to produce limited commercial quantities.
Polyester fiber	.....	Beaunit Mills Puerto Rico	Fiber similar to Dacron will be based on new Goodyear polyester resin, Videne.	10 million-lb./yr. fiber plant to use half the output of Goodyear's $9 million Apple Grove, W. Va. polymer plant.
Textiles	Bleaching	Columbia-Southern Chemical Co. Pittsburgh, Pa.	Hydrogen peroxide and sodium hypochlorite have been combined to reduce use of chemicals and lower cost of bleaching.	Technique in development stage.
Textiles, unspun	Forming	C. H. Dexter & Sons, Inc. Windsor Locks, Conn.	Textile, neither woven nor nonwoven, seeks generic name. Made 100% of Dacron fibers which are mixed in pure water, fed through controlled channels to a fine wire mesh.	Developed in conjunction with Du Pont for use as garment interlining.

Technology Advances

Operation	Equipment	User	Features	Remarks
Acid recovery....	Dialysis.....	Graver Water Conditioning Div., Union Tank Car Co. New York, N. Y.	Development of homogeneous vinyl membrane permits recovery of 90% of acid in waste streams with only small amounts of impurities. Used in filter-press type unit, membranes will last up to 2 yr., will diffuse as much as 0.5 lb./hr./sq. ft.	First successful use of dialysis for acid recovery. Formerly used for caustic recovery.
Air coating.....	Tower coater.....	Several drug firms	Coating solution atomizes into air stream, deposits on 16–80-mesh particles suspended in stream. Decreases coating time from hours to minutes. Handles particles too small for pan-coating methods.	Better than 99% coating material is utilized.
Bioxidation.....	Plastic tower packing	Dow Chemical Co. Midland, Mich.	Layers of corrugated Styron or Saran sheets (Dowpac) provide large surface areas to hold waste-treating bacteria in oxidation towers for liquid wastes.	Assembled in self-supporting units, Dowpac can be stacked to 42 ft.
Centrifuging.....	Continuous pressurized nozzle-bowl centrifuge	Phillips Petroleum Co. Bartlesville, Okla.	Removal of catalyst from polyethylene solutions at elevated temperatures. Since polymer solution has vapor pressure of several atmospheres, needed pressurized centrifuge.	Removes 99% of spent catalyst. Pressurized centrifuge developed jointly by Phillips Petroleum and Dorr-Oliver.
Circuit control...	Electrochemical switch	.....	Application of d.c. stimulus to grid electrode of new relay (consisting of grid electrode, two oxide-coated load electrodes, all immersed in electrolyte) allows delivery of a.c. current to load.	Developed by Ovitron Corp., Detroit, prototype has ratings of 3–70 v. at 4 amp. Claimed capable of endless use.
Coating.....	Plasma arc torch.	Linde Co. Indianapolis, Ind.	Stream of inert gas flows at high velocity through arc struck between torch electrodes carrying molten coating material to surface of work piece. Torch can be used for coating or forming.	Process lends itself to applying many high-temperature materials to virtually any material at controlled temperatures up to 30,000 F.
Coated powders..	Fluidized bed....	Battelle Memorial Inst. Columbus, Ohio	Seed powders to be coated feed into top of heated cylindrical reactor. Hydrogen plus off-gases from sublimer containing metal-coating salts enter bottom of reactor. Hydrogen reduction of salt vapors coats powders.	In pilot stage, applications in production of nuclear fuels or catalysts.
Cooling.....	Redwood towers..	U. S. Forest Products Lab Madison, Wis.	Use of chlorine as an algaecide is directly responsible for deterioration of redwood in cooling towers. Chlorine rapidly delignifies the wood.	Using nonoxidizing algaecide virtually eliminates such deterioration.
Corrosion prevention	Anodic protection.	Continental Oil Co. Baltimore, Md.	Impressed current builds up protective oxide film on surface of material under corrosive attack. Cathode is platinum, electrolyte is corrosive solution. Process can't handle halogens, reducing environments or copper-base metals.	Anatrol process, as technique is known, stops attack on steel by such corrosives as HNO_3, NaOH, NH_4NO_3.
Cyanide recovery.	Ion exchange....	Stilfonen Gold Mining Co. Transvaal, Union of South Africa	Permanently fouled resin, which would otherwise be discarded from the uranium plant, is used to recover cyanide, water and complexed base metals from gold mill effluent.	Pilot plant studies successful.
Drying.....	Dielectric heater..	.....	Recommended for heat-sensitive materials, glass-fiber-reinforced plastic buckets carry wet product between sets of electrode plates. Drying is extremely rapid at about 212 F. with high-frequency (30 megacycles), high-power (200 kw.) machine which evaporates 2 lb. water/kw.	In use for drying rayon fiber from pot spinning, developed by New Rochelle Tool.
Electricity generation	Thermoelectric generator	Westinghouse Electric Corp. Pittsburgh, Pa.	100-w. generator using propane flame as heat source converts heat to electricity with a mixed valence compound such as indium arsenide. Current flows when electrons jump into spaces vacated by other electrons.	Weighs 40 lb., has no moving parts and operates at 850 F.
Electricity production	Magneto hydrodynamic generator	General Electric Co. Schenectady, N. Y.	Lab-scale unit utilizes well-known principle (that electricity is generated when hot ionized plasma passes through magnetic field) to produce 5-sec. bursts of 1,000-w. power.	End use, if perfected, will be in space vehicles. Use of exhaust gases predicted.
Electricity generation	Plasma thermocouple	Los Alamos Scientific Lab Los Alamos, N. M.	Electric plasma replaces one of two metals normally used in a thermocouple to give continuous conversion of heat to electrical energy without moving parts.	Experimental.
Electricity generation	Thermionic converter	General Electric Co. Vallecitos, Calif.	Using radioactive isotope such as gold (Au-198 and Au-199) as heat source, thermionic converter boils electrons off its hot side and collects them on the cool side to produce an electric current.	Developed for outer space use, first unit had 4% efficiency, may eventually reach 10%.
Electricity generation	Nuclear generator	Los Alamos Scientific Lab Los Alamos, N. M.	Uranium carbide element is activated by a neutron flux from a nuclear reactor and the collector surface cooled by reactor coolant. Plasma thermocouple generates open-circuit voltage of 3.8 v., short-circuit current of 30–40 amp.	Research power reactor two years away.
Electrolysis.....	Platinized titanium electrodes	.....	Claim low voltage drop reduced power consumption, minimized maintenance and wear on anodes. Imperial Chemical Industries lists electroplating, mechanical and metal-spraying techniques for attaching Pt to Ti. Ionics ,Inc. claims chemical attachment.	Production and sales agreement between ICI and Englehard Industries (Newark, N. J.). Ionics, Inc. is using commercially as anodes in electrodialysis units.
Foam separation..	.....	Radiation Applications, Inc. New York	A surface-active complexing agent is added to an aqueous solution of metal ions which is then blown with gas to produce foam. Foam concentrates metal ions.	Single-stage enrichment factors as high as 40 have been obtained.
Flow measurement	Magnetic meter..	.....	Magnetic flowmetering operates only on conductive liquids. New idea is to add very small quantities of conductive liquids to nonconductive liquids such as hydrocarbons.	Being researched during 1959 by Fischer & Porter Co
Leaching.....	Bacteria.....	Kennecott Copper Co.	Naturally occurring Fe oxidizing bacteria regenerate leaching solution (ferrous sulfate to ferric sulfate) which is recycled to leaching stage. Bacteria are tolerant to high Cu level.	Patent issued.
Leaching.....	High pressure....	Texaco Development Corp. Beacon, N. Y.	Low-grade ores are ground and slurried, then heated to high temperature and pressure. Release of pressure pulverizes ore particles, simplifying leaching with NH_3 and CO_2.	On low-grade zinc ore, process yielded Zn carbonate at 57% Zn, 93% recovery.

Technology Advances—Continued

Operation	Equipment	User	Features	Remarks
Mechanical power production	Jet-turbine.....	Columbia-Gulf Transmission Co. Clementsville, Ky.	Program calls for modified Pratt & Whitney J-57 jet engine, coupled to a Cooper-Bessemer gas turbine. Combination will deliver 10,500 hp. to a centrifugal compressor.	Initial cost should run $190/installed hp. compared to reciprocating-type stations at $355/hp.
Metal melting....	Electron beam...	NRC Equipment Corp. Newton Highlands, Mass.	Furnace produces tantalum ingots 2.8 in. in diameter and up to 14 in. long. Useful for getting ultra-high purity in very high melting or highly reactive metal.	$60,000; separate vacuum systems for electron source and metal.
Metal melting....	Electron beam...	Air Reduction Co. Murray Hill, N.J.	Advantages similar to National Research Corporation's welder	Custom designed for beryllium, hafnium, tantalum, tungsten, zirconium, columbium.
Metal melting....	Electron beam...	Stauffer-Temescal Richmond, Calif.	Stauffer-Temescal established in electron-beam furnaces—one sold to Wah Chang for columbium.	Says welder can do 3,000 lb./mo. of tantalum.
Metal welding....	Hydrogen-NF_3 torch	Allis-Chalmers Mfg. Co. Milwaukee, Wis.	Self-fluxing hydrogen-nitrogen trifluoride torch can weld, braze and cut metals without additional flux.	Torch has 0.250-in. outside diameter.
Mixing, gas-liquid.	Baffled cylinder..	Oesterreichische Stickstoffwerke AG Linz, Austria	Baffled horizontal cylinder has three inlets, one outlet. Small, variously angled pipes on baffle plates divert one incoming stream; other two incoming streams pass through perforated sheet.	Material contacted in many small streams at high turbulence, low primary energy levels.
Mixing.....	Continuous rubber mixer	.....	Tapered, fluted rotor revolves in a smooth tapered stator, and subjects rubber and compounding ingredients to intense shearing action. Continuous mixer gives better control, greater uniformity and improved economy.	Developed by B. F. Goodrich and National Rubber Machinery. Laboratory model (5½-in. rotor) is in operation.
Moisture measurement	Plutonium-239 capsule	General Motors, Central Foundry Div. Danville, Ill.	Plutonium, mixed with beryllium powder, sealed in stainless steel capsule and inserted in batch of molding sand measures moisture. Slow neutrons—from collisions of fast plutonium neutrons with hydrogen nuclei in water atoms—are counted to indicate moisture content.	First AEC-authorized plutonium application of its kind improves GM's sand-molding ability.
Particle sizing....	Fine-mesh sieve..	Shell Development Co. Emeryville, Calif.	Square-hole sieve, made by photographic-electroplating process, is used to size cracking catalyst. Sieve hole sides are as small as 0.0002 in., a size where woven wire screens are unreliable.	May be accepted as standard by ASTM.
Pilot plant.....	Computer control.	Esso Research & Eng. Co. Bayway, N.J.	Pilot plant built around Royal-McBee LGP-30 computer for general purpose catalyst evaluation.	Plant is joint effort of Esso and Consolidated Electrodynamics.
Power generation.	Fuel cell.....	Various.....	(1) Hydrogen-oxygen—most advanced, highest power outputs and current densities. (2) Molten-salt—possible use of cheap fuels is attractive for large plants. (3) Redox—use of chemical intermediates simplifies system, permits use of impure fuels. (4) Regenerative—needs cheap source of energy for fuel regeneration. (5) Consumable electrode—low operating temperatures, high power-to-weight ratios. (6) Ion exchange—eliminates liquid electrolyte.	(1) National Carbon, National Research & Development (Gr. Britain), Universal Winding Co. (2) Consolidation Coal, GE and Curtiss-Wright. (3) GE, Lockheed Aircraft. (4) Mine Safety Appliances. (5) National Carbon, Aerojet General. (6) GE.
Power generation.	Plutonium reactor	Atomic Energy Commission Idaho Falls, Idaho	Successful recovery of plutonium from power reactors and use as a reactor fuel may lower uranium consumption and save on cost of reactor fuel.	Materials Testing Reactor produced 30,000 kw. of power with plutonium core.
Process control...	Computer.....	Texas Co. Port Arthur, Tex.	Polymerization of 15 million cu.ft./day of refinery gas, into blending stock for hi-test gasoline, via complete computer control which evaluates input gas analysis, pressures, temperatures, flow rates, etc. Computer automatically resets plant controls every 5 min., sounds alarm in case of abnormal operation or failure.	Thompson Ramo Wooldridge equipment (RW-300). More efficient catalyst use expected to save $75,000/yr. May increase overall efficiency 6–10%.
Radiation detection, measurement	Ionization detector	.....	Solid-state ionization chamber, essentially a piece of doped silicon, emits electrical pulse when struck by charged nuclear particle. Pulse can be measured and analyzed. Device is inexpensive and speeds up and simplifies detection.	Developed by Hughes Aircraft Co.; to be available commercially soon.
Reaction studies..	Shock tubes.....	Several	By shock-tube techniques, reactants for particular chemical synthesis can be heated to 5,000 C., reacted and cooled to room temperature—all in a few milliseconds. Ideal for data seekers on high-temperature gas reactions.	Autoclave Engineers and American Hollow Boring Co. (both Erie, Pa.) can supply packaged setups.
Refrigeration.....	Absorption cycle..	Southwest Research Institute San Antonio, Tex.	Use of multiple-effect evaporation in absorption refrigeration cycle improves coefficient of performance 50%, cuts fuel 30% and cooling water 25%.	SWRI has operated 3-ton prototype.
Rubber drying...	Modified Banbury mixer	.....	Beefed-up Banbury mixer heats rubber to drying temperature by mechanical action. Process estimated to save $5–10/ton over hot-air drying, much more on vacuum drying. Banbury's shorter drying cycle cuts equipment needs.	Process available for license from Patent and Licensing Corp., wholly-owned subsidiary of Flintkote (N.Y.). Royalty charges: about $1/ton rubber.
Separation.....	Permeable film...	American Oil Co. Texas City, Tex.	Permeable film permits splitting of close-boiling, wide-boiling and azeotropic mixtures often more cheaply than distillation or solvent extraction. One-stage unit can separate 80–90% pure material from 50–50 mixture.	Pilot-plant stage, licensed to Ionics, Inc.
Sewage sterilization	Ozone contacting column	U. S. Army Chemical Corps Fort Detrick, Md.	Lab studies show that bubbling ozone through columns of liquid sewage waste is cheapest effective way to sterilize sewage.	Details of study in report No. PB 129375, Library of Congress.
Sludge disposal..	Atomized suspension	Community of Beaconfield, Quebec	Raw-sewage slurry (10% solids) feeds into top of reactor tower via atomizing nozzles. Tower walls, held at 1,000–1,400 F., emit radiant heat that flashes slurry water, and dries solids before they reach middle of tower. Air enters at middle of tower, burning the solids to ash.	Unlike spray drying, no hot gases are introduced into tower with feed.
Solids separation..	Electrostatic vibrator	General Mills Minneapolis, Minn.	Vibrations feed mixed material onto electrically grounded lower tray. Charged upper tray (several thousand volts) 2–6 in. above induces electrostatic field between trays. One material picks up greater charge, jumps to upper tray.	Tested on pilot and commercial scale models.

Technology Advances—Continued

Operation	Equipment	User	Features	Remarks
Space propulsion..	Ion rocket.....	Rocketdyne, Inc. Canoga Park, Calif.	Cesium propellant is vaporized and fed to electrically charged chamber. Electron is pulled from each atom. Positive ions thus created are accelerated to 300,000 mph. by electrostatic field, and then discharged to provide desired thrust.	System under study portends birth of usuable ion rocket within 5 yr.
Sterilization.....	Microwave linear accelerator	Johnson & Johnson, Ethicon Division Rahway, N.J.	7 mev. electron beam produced by a linear accelerator is used to sterilize up to 10 dozen sutures per min. This is done in sealed packages, eliminating danger of contamination in handling.	Process in use since early 1958.
Temperature reduction	Electromagnet...	University of California Berkeley, Calif.	Powerful electromagnet allows close approach to absolute zero. Magnet, about 2 ft. long by 15 in. diameter, produces 96,700 gauss over 30 cu.in. working area. Circulating 2,200 gal./min. kerosene removes heat generated by 6,000 kw. input. A paramagnetic salt is brought to helium boiling point. By boiling off helium under vacuum, salt is brought to 1 deg. above absolute zero.	Used in research at University.
Transport of coal.	Pipeline.....	Consolidation Coal Co. Pittsburgh, Pa.	Water slurry of fine clean coal is pumped 108 miles from mine preparation plant to power station where it is dewatered and burned.	In operation, fall of '58 from Georgetown to Eastlake, Ohio.
Transport of liquid	Collapsible rubber containers	Esso Standard Oil Co. Bayway, N.J.	Esso ships distillate liquid products in collapsible 34 ft.-long rubber container, which is cheap to return.	Wide commercial use. Esso ships from Bayonne, N.J. to Auburn, N.Y.
Transport of methane	Tanker.....	Constock Liquid Methane Corp. New York, N.Y.	On 23-day voyage from La. to Britain's River Thames, 2,000-ton specially built tanker lost only 10% of liquid methane cargo. Balsa-lined aluminum tanks. Special pumps.	Constock designing tanker that will use vapor to supplement fuel supply.
Transport of oil..	Pipeline.....	Research Council of Alberta Edmonton, Alberta	Injection of water into oil pipelines and control to locate it between oil and pipewall could greatly reduce frictional drag and pumping cost.	Theoretical study to lower cost of pumping heavy crude from tar sands.
Transport of solids	Water-borne sphere	Crown Zellerbach Canada Fraser River, B. C.	8-ft. plastic sphere is stuffed with wood chips and floats free 50 miles downstream at a steady 2 mph. Sphere is glass-fiber-reinforced plastic, 1/8 in. thick.	First test a success. Further tests planned for spring 1960.
Transport of sulfur	Hot-product pipeline	Freeport Sulfur Co. Grand Isle, La.	Composite pipeline carries molten sulfur underwater from offshore mine to shore, 7 mi. away. Innermost pipe carries sulfur; next carries hot water. The water pipe is insulated and equipped with rollers that ride in third, outermost pipe.	Now complete unit can handle 4,500 long tons/day sulfur at 300 F.
Waste treatment..	Air oxidation....	Sherwin-Williams Co. Chicago, Ill.	Air oxidation of waste sulfite liquors from manufacture of chemicals with cobalt chloride catalyst, satisfactorily treats them before discharge to the Metropolitan Sanitary District of Greater Chicago. Equipment built by Mixco and Yeomans.	Semipilot-plant studies successful.
Waste treatment..	Ozonator.....	Cities Service Oil Co. Bronte, Calif.	After three-stage biological oxidation rids refinery waste water of most phenol, ozone contact in stainless steel treater, followed by contact with activated carbon, cuts level to 0.012 ppm.	Ozone generator-contactor combination for 300 gpm. water cost $120,000.
Waste treatment..	Rotary filter.....	.....	Organic color bodies in kraft pulp waste react with hydrated lime precoat on filter. Thin layer of waste-coated lime is doctored off and burned in kiln.	Pilot plant operation at Louisiana State University.
Waste treatment..	Wet combustion..	Metropolitan Sanitary District of Greater Chicago Chicago, Ill.	Sterling Drug's Zimmerman process wins commercial berth in 200-ton/day waste disposal plant. Claimed superior to and more economical than conventional methods.	$12 million contract. Project completion in 18 months.
Welding.....	Electron beam...	General Electric Co. Richland, Wash.	Beam of focused high-velocity electrons welds work piece in vacuum chamber. Besides giving high-quality welds on commonly used metals, technique also handles reactive metals such as Zr, Ti and Cb.	.....
Welding.....	Ultrasonic.....	Aeroproject, Inc. Chester, Pa.	High-frequency (above 15 kc.) mechanical vibrations transduced from electric energy pass along coupling bar to welding tip. Useful in both spot and seam welding, mechanism appears to give more intimate contact of welding surfaces due to grinding action of vibrating tip.	.....
Welding, foil.....	Ultrasonic.....	Aluminum Co. of America Pittsburgh, Pa.	Splices lengths of aluminum foil into large rolls. Aluminum, a soft, difficult-to-weld metal, is said to be easily joined by ultrasonic method. Gives thin, strong seams and eliminates heat sealed adhesives that create large, heavy splices which must later be removed.	Aeroprojects, Inc. helped in development. Copper may also be amenable.
Vacuum production	Cryopump.....	University of Southern California Los Angeles, Calif.	Combination of mechanical pump and helium-cooled refrigeration can produce one-billionth atm. vacuum at about one-tenth of power required in most efficient conventional system. In large wind tunnel application, 50-hp. motor powers system compared to equivalent 500,000 hp. gaseous diffusion pump that would be required.	.....
Vessel lining.....	Expanding mortar	Various	Brick lining laid cold within vessel, using special corrosion-resistant mortar. When heated, steel vessel expands; so does lining. On cooling, lining doesn't contract, steel therefore stresses it, preventing later cleavage.	Old process in Europe; new to U. S. Mortar made by Pennsalt Chemical Co., Philadelphia.
Vulcanisation....	Continuous liquid vulcanizer	Various	Extruded, uncured elastomer compound feeds through bath of molten metal, or organic, or silicone liquid. Temperature of 400 to 600 F., compared to batch at 300 F., cures material in seconds.	Commercial, developed by Du Pont.

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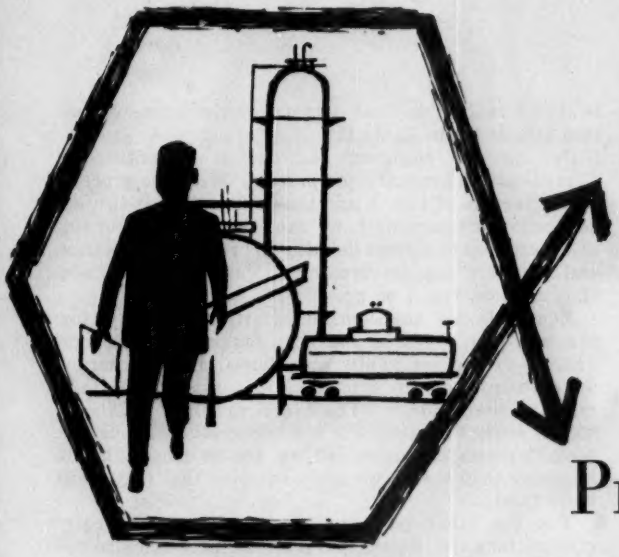


Systems Engineering, Part 4

Preliminary Design

Working from fundamental statements of the processing scheme and initial economics, the systems engineer starts plant design.

THEODORE J. WILLIAMS, Monsanto Chemical Co., St. Louis, Mo.

The kinetic model developed in Part 2* is the basis for a study of plant design methods by the systems engineering approach. This approach, as we've noted before, is characterized by present trends in computer applications to design and optimization problems in the chemical process industries.

Our plant will be designed to meet the requirements imposed by management of Quandary Chemical Co. on Joe Smirk, the project engineer. Their memo, in Part 2, directed that a plant to produce *P* be designed and built. Smirk has used the systems engineering group to help in the research and development stages and found that their techniques have speeded up these stages.

Now we are ready to consider plant design—at least its preliminary stages. In order to keep the presentation as simple as possible within the limits of our space, we are forced to make many simplifications and eliminate much detail. Every effort has been made, however, to avoid straining the reality of the case presented.

Essentially the same processing model as we propose here has been distributed to the control computer manufacturers and potential process company users of computer controllers.[4] Its use has been suggested as an example to test applicability of computer control in the process industries.[1, 3]

Determine Physical Properties

In previous chapters, we have shown how systems engineering aids reaction kinetics development and selection of reactor type. In any effective plant design it's also necessary to have a well-defined knowledge of the physical properties of each of the components and mixtures to be found in the process scheme. A systems-engineered plant differs from no other in this respect.

Since these properties must be developed by the chemical research group, the best time to conduct necessary experiments is during the period that computer personnel are developing the reaction mechanism for the process. In this way, each group carries out that task for which it is best qualified, and the new plant can be put onstream in the shortest possible time.

The necessary data include density, viscosity, vapor-liquid equilibria, solubility and heat conductivity. Many groups are working to develop computer methods for predicting such data,[2] but while these efforts show much promise, a great deal of work remains to be done.

For our system, Table I and Figs. 1-3, together with the data on reaction coefficients and vapor-liquid equilibria relations presented in Figs. 9 and 10, Part 2 show the available physical property data.

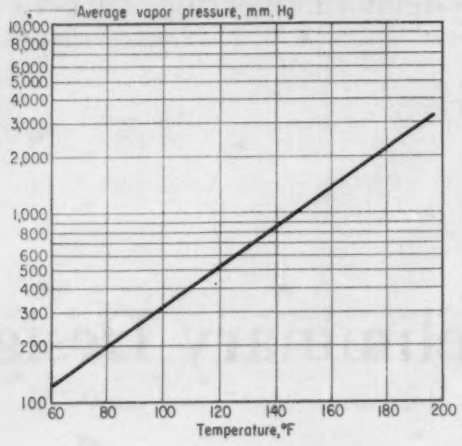
Over-All Design Considerations

The insolubility of heavy oil *G* in the reaction mixture at low temperatures (Fig. 3) suggests that a decanter may be an effective separation device to use in the process. This choice would necessitate cooling of the reactor effluent to 100 F. or less. The decanter overflow could be distilled to remove the desired product *P* as overhead.

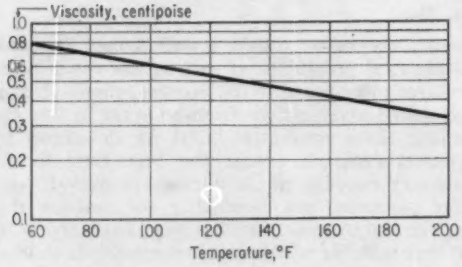
Column bottoms, which would contain some *P* due to the azeotrope, plus *E*, *A*, *B* and *C*, could be recycled to the reactor for further reaction. A discard stream must also be taken off the distillation column bottoms to prevent excessive buildup of component *E*. These considerations result in a process flow diagram such as

* The series on systems engineering, based on the 1959 Schoch Lecture at the University of Texas, started in *Chemical Engineering*, Feb. 8, '60, pp. 121-6. Part 2 appeared in *CE*, Mar. 7, '60, pp. 131-6; Part 3, *CE*, Apr. 4, '60, pp. 139-44.

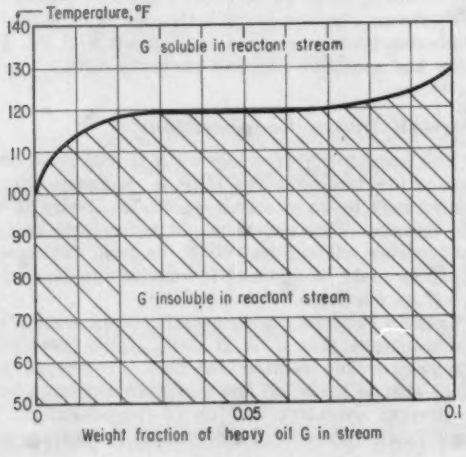
Vapor pressure of reactant mixture less G—Fig. 1



Viscosity of reactant mixture—Fig. 2.



Solubility of G in plant streams—Fig. 3.



is shown in Fig. 4. Cost data for the process evaluation are shown in Table II.

Our project engineer has chosen a continuous stirred-tank reactor for the process. With the process block diagram of Fig. 4, and the assumptions indicated for each equipment unit, we can write a complete set of differential equations defining the reaction dynamics and the plant process dynamics. These equations are shown below Fig. 4 on pp. 124-25.

Equations for the continuous stirred-tank reactor are based on material balances for each component (Eqs. 1-6) and for total stream flows (Eq. 7), and on an enthalpy balance expressed in terms of reactant mixture temperature. These are dynamic equations in the sense that they are time-dependent: hence the term "process dynamics." They are no more difficult to derive than the steady-state balances that may seem more familiar.

For the other plant units, equations are equally straightforward. Subscripts refer, in most cases, to the stream or location of component, temperature or flow rate involved.

Assumptions for Process Dynamics

There are certain assumptions that apply in general to the process model equations. They are:

• Since every effort has been made to keep the plant as compact as possible, we will consider fluid line

Physical Properties of Components—Table I

Molecular weights, M_i	
Components A, B and P	100
Components C and E	200
Component G	300
Densities, ρ	
Typical reactant mixture	50 lb./cu.ft.
Component G	68.6 lb./cu.ft.
Other reactant mixture properties	
Heat capacity, C_{PR}	0.4 Btu./(lb.)(°F.)
Heat of vaporization	95 Btu./lb.
Thermal conductivity, k_R	0.086 Btu./(hr.)(sq.ft.)(°F/ft.)
Vapor pressure	See Fig. 1
Viscosity, μ	See Fig. 2
Heat of reaction	
Reaction 1, H_1	−125 Btu./lb. of C produced
Reaction 2, H_2	−50 Btu./lb. of $E+P$ produced
Reaction 3, H_3	−143 Btu./lb. of G produced
All reactions are exothermic.	

Vapor-liquid equilibria

Product P has a relative volatility α of 2.2 in comparison with liquid of composition of average column bottoms stream including P entrapped in azeotrope form with material E.

These Are Economics Used for Preliminary Plant Design—Table II

Product P

Total sales available	40,000,000 lb./yr
Excess production must be discarded	
Sales price	$0.30/lb.

Byproduct (discard stream)

Fuel value	$0.0068/lb.
All produced can be used	

Reactant A

Cost	$0.02/lb.

Available from another process unit in same plant complex. Supply is under some restrictions in that other process unit also feeds *A* to several other batch operations in the complex.

Reactant B

Cost	$0.03/lb.

Available from outside supplier in any quantity

Utility costs

Steam	$1.00/thous. lb.
Water	$0.25/thous. gal.
Electricity	$0.01/kwh.
Waste disposal	$0.01/lb. of *G*

Over-all cost equation for preliminary plant design study:

$$\%\ \text{return} = 100 \times [8{,}400(X) - 2.22(F_R) - (0.124)(8{,}400)(0.30F_P + 0.0068F_D) - 60V_R] \div 600V_R$$

where

1. 8,400 operational hours per year are assumed.
2. $X = 0.30F_P + 0.0068F_D - 0.02F_A - 0.03F_B - 0.01F_G$
3. $F_P = 4{,}763$ lb./hr.
4. $600V_R$ is a factor for estimating gross capital; $60V_R$ is corresponding factor for depreciation.
5. Sales, administration, research and engineering costs factor, computed on gross return, is 0.124.
6. Utility charges factor is 2.22.

dead-time between the various plant units is negligible. Too, no dead-times have been considered in any plant unit.

- Loss of heat to atmosphere has been considered negligible for all units.
- All volumes are expressed as pounds of contained liquid of density of 50 lb./cu. ft.
- All compositions are expressed as weight fractions.

Other assumptions that apply to specific process units are contained in the table of equations with Fig. 4 that describes the dynamics for those units. All assumptions are more critical for dynamic response of the system than they are for economic optimization. The latter is calculated as the steady-state solution of the set of differential equations.

While the simplifying assumptions may appear severe, they are necessary to get the complete plant system on present-day analog computer equipment. As computers increase in size, fewer such assumptions will need to be made. In any case, our set of equations is still extremely valuable.

To carry out the preliminary plant design by computer, one other equation must be added to the process dynamics equations. This is the over-all cost equation which is shown in Table II, along with the economic information that it uses.

After appropriate programming, the combined sets of equations are solved on both analog and digital computer equipment. The analog computer is used to map out areas of interest, and the digital computer permits the greatest accuracy you may require. The results of these solutions—a set of relationships of percent return *vs.* various plant parameters—are shown in Figs. 5-8. By choosing the appropriate values of significant flow rates, equipment sizes, etc., from these relationships—in this case those at which percent return is maximum—over-all plant size and material balances are easily obtained. Table III shows the results for our case.

Figs. 6 and 8 include broken-line curves that cover the case of greater production than the specified 40,000,000 lb./yr. of *P*. Point 1 on both is the point at which production must exceed 40,000,000 lb. annually. Curve 2 in Fig. 6 is percent return if such excess production must be discarded; the straight broken lines of Fig. 8 show return if such production must be discarded. If, on the other hand, the excess production can be sold, the straight broken line in Fig. 6 is the return, and curves 2 of Fig. 8 are also resulting returns.

Temperatures of various streams are also determined. With reactant streams at 70 F. and recycle stream at 100 F. entering reactor that operates best at 180 F. (see Fig. 7), 10,400 lb./hr. of reactor coolant should enter at 60 F. and leave at 92 F. In order to stop reaction in cooler following the reactor, 153,000

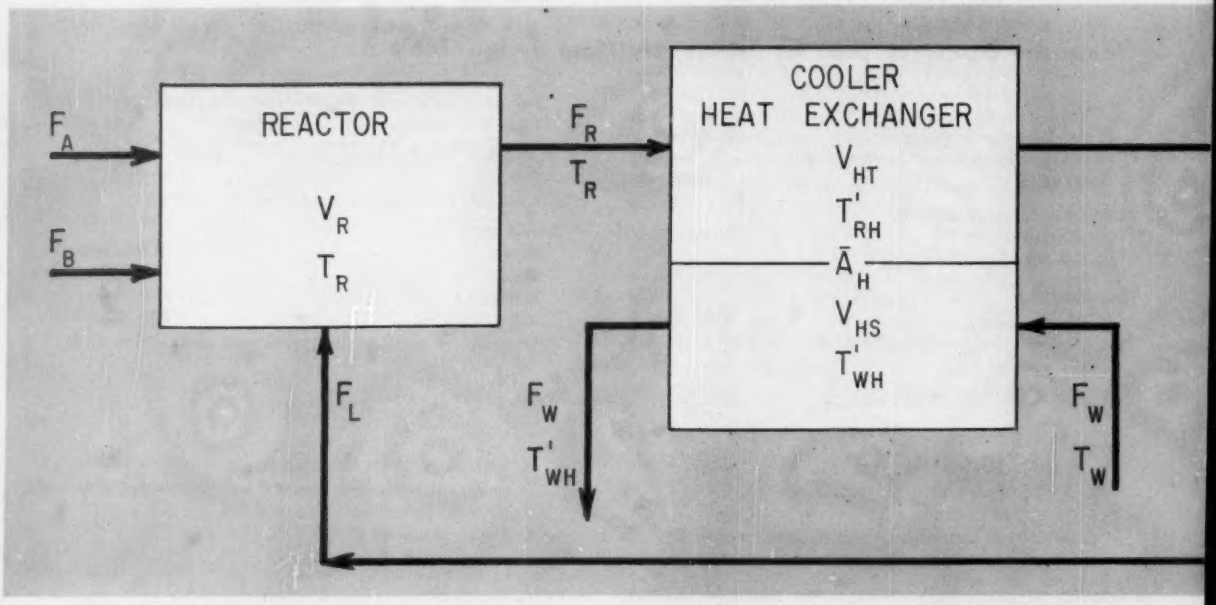
Continued on p. 126

Nomenclature

C_P	Heat capacity; subscript identifies stream.
F	Flow rate.
T	Temperature; subscript identifies location.
T'	Average reaction cooler-exchanger temperature.
V	Volume.

Subscripts

RH	Reaction effluent mixture in tube side of reaction cooler-exchanger.
WH	Coolant in shell-side of reaction cooler.
HT	Tube side of reaction cooler.
HS	Shell side of reaction cooler.
w	Water used as coolant.
z	Steam used as heating medium.



Stirred-Tank Reactor

• Reactor can be considered well-stirred, and reactants and products are at all times completely mixed.

• Over-all reaction rates are expressed as pounds of component produced per hour per pound of reactor volume.

$$dA_R/dt = (F_A/V_R) + (F_L/V_R)[A_L] - (F_R/V_R)[A_R] - k_1[A_R][B_R] \quad (1)$$

$$dB_R/dt = (F_B/V_R) + (F_L/V_R)[B_L] - (F_R/V_R)[B_R] - k_1[A_R][B_R] - k_2[B_R][C_R] \quad (2)$$

$$dC_R/dt = (F_L/V_R)[C_L] - (F_R/V_R)[C_R] + 2k_1[A_R][B_R] - 2k_2[B_R][C_R] - k_3[C_R][P_R] \quad (3)$$

$$dE_R/dt = (F_L/V_R)[E_L] - (F_R/V_R)[E_R] + 2k_2[B_R][C_R] \quad (4)$$

$$dG_R/dt = 1.5k_3[C_R][P_R] - (F_R/V_R)[G_R] \quad (5)$$

$$dP_R/dt = (F_L/V_R)[P_L] - (F_R/V_R)[P_R] + k_2[B_R][C_R] - 0.5k_3[C_R][P_R] \quad (6)$$

$$F_R = F_A + F_B + F_L \quad (7)$$

Residence time per pass $= V_R/F_R$ (8)

$$dT_R/dt = (1/V_R\rho_R C_{PR})\,[2(k_1[A_R][B_R])V_R H_1 + 3(k_2[B_R][C_R])V_R H_2 + 1.5(k_3[C_R][P_R])V_R H_3 - h_w A_w(T_R - T_W) + h_s A_s(T_R - T_S) - F_L C_{PL}(T_R - T_L) - F_A C_{PA}(T_R - T_A) - F_B C_{PB}(T_R - T_B)] \quad (9)$$

$$k_i = A_i e^{-B/T}, \text{ where } i = 1,2,3 \quad (10)$$

Reaction Effluent Cooler-Exchanger

• For first approximation, dynamics of the heat exchanger may be considered those of two well-mixed tanks: one for the reactor effluent stream and one for the coolant. This assumption requires a correction factor for effective cooling area which is given in Eq. 13.

$$dT_{RH'}/dt = (1/V_{HT}\rho_R C_{PR})[F_R C_{PR}(T_R - T_{RH'}) - h_H \bar{A}_H(T_{RH'} - T_{WH'})] \quad (11)$$

$$dT_{WH'}/dt = (1/V_{HS}\rho_W C_{PW})[F_W C_{PW}(T_W - T_{WH'}) + h_H \bar{A}_H(T_{RH} - T_{WH})] \quad (12)$$

$$\bar{A}_H = A_H(T_{RH'} - T_{WH'})_{lm}/(T_{RH'} - T_{WH'}) = \text{effective area} \quad (13)$$

where

$$(T_{RH'} - T_{WH'})_{lm} = [(T_R - T_{WH'}) - (T_{RH'} - T_W)] \div \ln[(T_R - T_{WH'})/(T_{RH'} - T_W)]$$

and $(T_R - T_{WH'})$ is difference of entrance reactor effluent temperature and exit coolant temperature; $(T_{RH'} - T_W)$ is difference of exit reactant stream temperature and entrance coolant temperature.

$$dA_H/dt = (F_R/V_{HT})([A_R] - [A_H]) \quad (14)$$

$$dB_H/dt = (F_R/V_{HT})([B_R] - [B_H]) \quad (15)$$

$$dC_H/dt = (F_R/V_{HT})([C_R] - [C_H]) \quad (16)$$

$$dE_H/dt = (F_R/V_{HT})([E_R] - [E_H]) \quad (17)$$

$$dP_H/dt = (F_R/V_{HT})([P_R] - [P_H]) \quad (18)$$

$$dG_H/dt = (F_R/V_{HT})([G_R] - [G_H]) \quad (19)$$

Decanter

• Decanter can be considered well-mixed in the layer of material that feeds to distillation column (overflow). There is no mixing between the light layer and the heavy layer in the decanter.

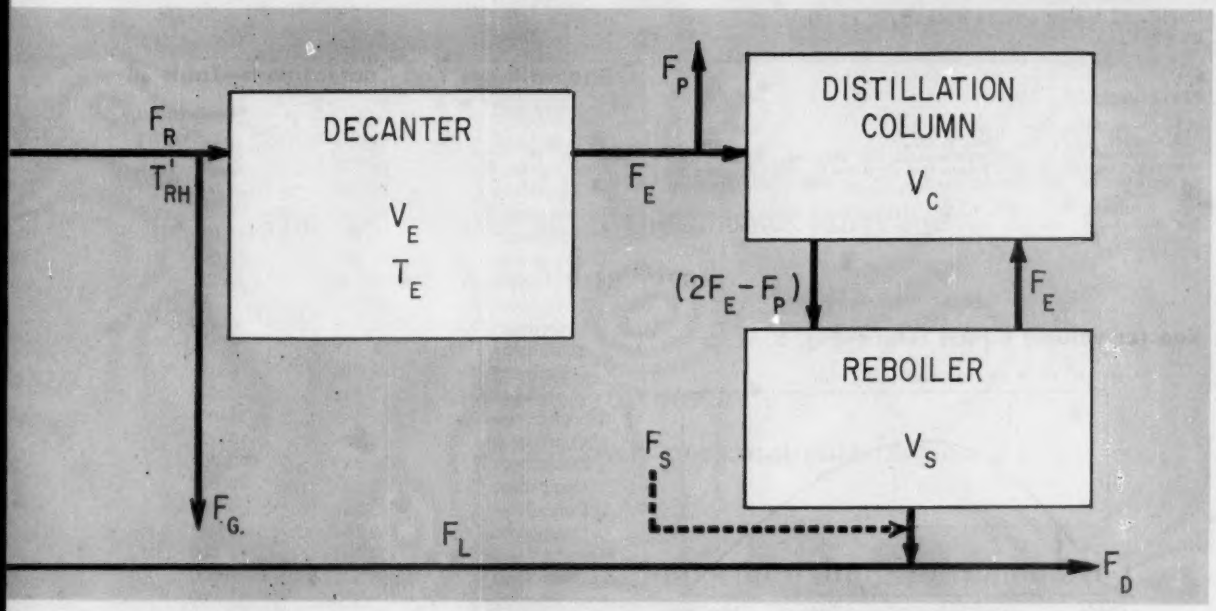
$$F_G = G_R F_R \quad (20)$$

$$F_E = F_R - F_G \quad (21)$$

$$dA_E/dt = (F_R/V_E)[A_H] - (F_E/V_E)[A_E] \quad (22)$$

$$dB_E/dt = (F_R/V_E)[B_H] - (F_E/V_E)[B_E] \quad (23)$$

$$dC_E/dt = (F_R/V_E)[C_H] - (F_E/V_E)[C_E] \quad (24)$$



$$dE_E/dt = (F_E/V_E)[E_H] - (F_E/V_E)[E_E] \quad (25)$$

$$dP_E/dt = (F_E/V_E)[P_H] - (F_E/V_E)[P_E] \quad (26)$$

$$dT_E/dt = F_E C_{PH}(T_{RH}' - T_E)/V_E \rho_E C_{PE} \quad (27)$$

Distillation Column

• Since P is readily separated from other feed stream components by distillation, the column may be considered an instantaneous separator of F_P, i.e., F_P does not mix in the column.

• To compute column compositions as a function of time, we make the approximate assumption that the distillation column is a well-mixed tank with volume equal to total hold-up of the column.

$$F_P = (P_E - 0.1E_E)F_E \quad (28)$$

$$dA_C/dt = (F_E/V_C)[A_E] - (2F_E - F_P)[A_C]/V_C + (F_E/V_C)[A_S] \quad (29)$$

$$dB_C/dt = (F_E/V_C)[B_E] - (2F_E - F_P)[B_C]/V_C + (F_E/V_C)[B_S] \quad (30)$$

$$dC_C/dt = (F_E/V_C)[C_E] - (2F_E - F_P)[C_C]/V_C + (F_E/V_C)[C_S] \quad (31)$$

$$dE_C/dt = (F_E/V_C)[E_E] - (2F_E - F_P)[E_C]/V_C + (F_E/V_C)[E_S] \quad (32)$$

$$dP_C/dt = 0.1(F_E/V_C)[E_E] - (2F_E - F_P)[P_C]/V_C + (F_E/V_C)[P_S] \quad (33)$$

Distillation Column Reboiler

• Reboiler may be considered a well-mixed tank with volume equal to its given hold-up.

• Reboiler temperatures, and consequently recycle line temperatures, are a function of column operation and not of the temperature of the column feed stream, F_E. Therefore, temperature mixing equations have not been included for the column or reboiler.

• Reboiler boilup has same composition as reboiler liquid. Since vapor-liquid equilibria relations are not given, the exact composition of reboiler vapor cannot be determined.

$$dA_S/dt = [(2F_E - F_P)/V_S][A_C] - (F_S/V_S)[A_S] - (F_E/V_S)[A_S] \quad (34)$$

$$dB_S/dt = [(2F_E - F_P)/V_S][B_C] - (F_S/V_S)[B_S] - (F_E/V_S)[B_S] \quad (35)$$

$$dC_S/dt = [(2F_E - F_P)/V_S][C_C] - (F_S/V_S)[C_S] - (F_E/V_S)[C_S] \quad (36)$$

$$dE_S/dt = [(2F_E - F_P)/V_S][E_C] - F_S/V_S)[E_S] - (F_E/V_S)[E_S] \quad (37)$$

$$dP_S/dt = [(2F_E - F_P)/V_S][P_C] - (F_S/V_S)[P_S] - (F_E/V_S)[P_S] \quad (38)$$

Recycle and Discard Streams

$$F_S = F_D + F_L = F_E - F_P; \quad F_D/F_L = \text{constant} \quad (39)$$

$$[A_S] = [A_D] = [A_L] \quad (40)$$

$$[B_S] = [B_D] = [B_L] \quad (41)$$

$$[C_S] = [C_D] = [C_L] \quad (42)$$

$$[E_S] = [E_D] = [E_L] \quad (43)$$

$$[P_S] = [P_D] = [P_L] \quad (44)$$

$$T_L = T_D = T_S = \text{constant} \quad (45)$$

lb./hr. of water enters exchanger at 60 F. and leaves at 80 F.

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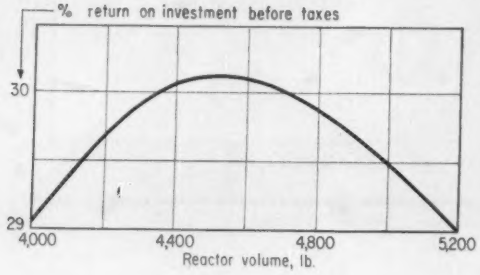
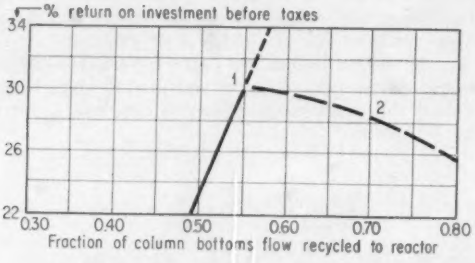
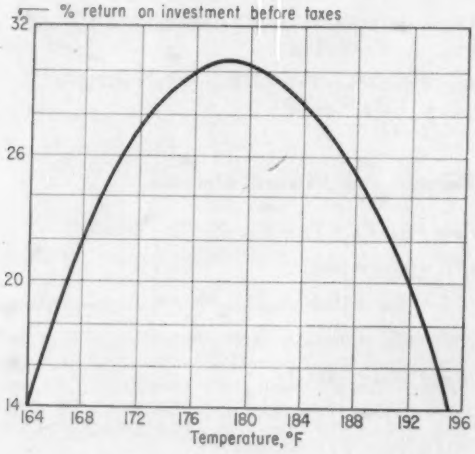
Reactor volume affects return—Fig. 5.



Recycle ratio affects return—Fig. 6.



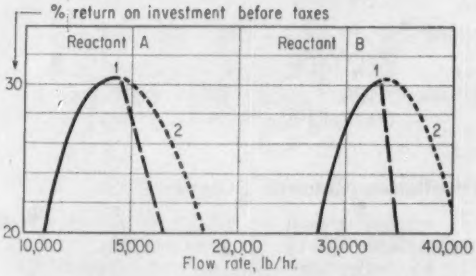
Reactor temperature affects return—Fig. 7



Stream Rates and Compositions—Table III

Stream	Rate, Lb./Hr.	Composition, Wt. Fraction
Feed stream, F_A	14,500	1.000
Component *A*	14,500	1.000
Feed stream, F_B	33,350	1.000
Component *B*	33,500	1.000
Cooler effluent, F_E	95,961	1.000
Component *A*	11,628	0.121
Component *B*	36,829	0.383
Component *C*	2,348	0.025
Component *E*	33,348	0.346
Component *P*	8,096	0.085
Component *G*	3,712	0.039
Decanter overflow, F_E	92,249	1.000
Component *A*	11,628	0.126
Component *B*	36,829	0.399
Component *C*	2,348	0.026
Component *E*	33,348	0.361
Component *P*	8,096	0.088
Decanter underflow, F_G	3,712	1.000
Component *G*	3,712	1.000
Column overhead, F_P	4,763	1.000
Component *P*	4,763	1.000
Column bottoms, F_S	87,487	1.000
Component *A*	11,628	0.133
Component *B*	36,829	0.421
Component *C*	2,348	0.027
Component *E*	33,348	0.381
Component *P*	3,334	0.038
Recycle stream, F_L	48,111	1.000
Component *A*	6,393	0.133
Component *B*	20,255	0.421
Component *C*	1,289	0.027
Component *E*	18,340	0.381
Component *P*	1,834	0.038
Byproduct stream, F_D	39,376	1.000
Component *A*	5,235	0.133
Component *B*	16,574	0.421
Component *C*	1,059	0.027
Component *E*	15,007	0.381
Component *P*	1,501	0.038

Flow rates of reactants affect return—Fig. 8



The best writing talks the normal language of men exchanging ideas.

They'll judge your article by their own personal satisfaction.

The important thing to remember is: You can write well!

PAUL R. HEINMILLER is now directing a study of technical communications at GE's general engineering laboratory in Schenectady. He is the former editor of the *General Electric Review.*

How to Write a Good Technical Article

The best engineering writing has been done by engineers with something to say. They did not presume any special knowledge of writing; with their readers in mind, they simply talked the normal language of men exchanging ideas.

Engineering, business and scientific publications of today move in the current of this tradition.

When you write an article, you have something in common with the doctor of medicine. The readers of your article, like the doctor's patients, are critical. They'll judge the success of your article by their personal satisfaction.

To write an article that will interest thousands of top-caliber technical and management men who read today's engineering, business and scientific publications requires a good deal of effort. It isn't easy. But the important thing to remember is: You can write well!

▶ **What to Write About**—Before you can write an article you must have something to say. A good indicator is your own interest. For almost anything that interests you can be made interesting and helpful to others.

Use these criteria to guide your choice: Is your subject significant? Will it give a reader the whole picture, not just a part? If so, can you present it comprehensibly to engineers somewhat removed from your own work?

Don't overlook the human side of technology either. Long experience in directing the work of others may qualify you to write about this subject.

Subjects to write about are as limitless as the innate curiosity of engineers themselves. It only remains for you to write in a readable and understandable manner.

▶ **Things to Remember** — Aim your article for a specific audience, for a specific magazine. Read through a few issues of the magazine you choose. This will

give you some understanding of its readers' likes and dislikes.

Visualize your reader from the start. You might try this: Choose someone in a field somewhat remote from your own, and then write your article for him. Write for a single flesh-and-blood reader. Don't write for an amorphous, ghostly group of thousands of subscribers.

Use plain talk. Be direct and to the point. Expository writing is at its best when you address the reader directly. Use the second person "you" as I have in this article. One obvious benefit: It will help to keep you out of the passive voice.

Explain or define any specialized terms. Remember, you are writing for an audience that may not be as familiar with the subject as you are. (Don't write for the engineer at the next desk. He knows all about it anyway.)

Nothing curbs a reader's interest so much as a conglomeration of formulas, graphs and tables. Before you use them, ask yourself, "Are they really helpful?"

▶**String Ideas Together**—Before you begin to write, chart the course. Outline your ideas on paper. Just as every good article has a beginning, a middle and an end, a good outline has three basic parts: introduction, body, summary. To make the outline more digestible, break it down further into subheads.

A good outline is the clay from which you mold your article. Once it's prepared, you are ready to write.

• Introduction is the all-important item. Here's where you win or lose the busy reader. To win him, you must arouse interest in your main theme. Normally, you'll have to supply enough background material to bring the subject into focus.

How do you arouse a reader's interest? That depends on your ingenuity. You might focus attention on an unusual feature. Or you can point out something within the reader's experience that he may never have thought of before. Another way—the easy one—is to analyze the introduction of a recent article that interested you.

• A good introduction leads smoothly into the body, or text, of an article. Fix the first heading of this section in your mind; and then begin to write, remembering that the reader should be able to grasp your meaning without excessive effort.

When you speak to a person, you unconsciously use the feedback principle. From his expression you can tell whether he is absorbing your ideas. You can slow down, repeat or speed up accordingly. In writing there's no feedback to set the pace. Instead you have to rely on an intuitive "feel" for the reader.

Here's where unity and continuity come in.

Unity simply means sticking to the subject and avoiding the pitfall of details that do not advance your main theme. Keep your subject always in mind, and you'll have little trouble with unity.

Continuity, the thread that weaves your article together, is more elusive. To achieve it, transitions between paragraphs, from one subhead to the next, should be smooth, continuous and logical.

• Any of the points you've made in the introduction and body should be driven home in the summary. It's like giving the nail a final whack. Re-echo your main theme. If, for example, you are writing about an unusual process, stress again any of its unusual features.

Closing an article with an optimistic statement about the future is a proved technique, provided that the statement is well-founded. In any event, say something definite. Leave the reader with the feeling that he has gained something in exchange for his time.

But don't say too much. Otherwise you'll have an anticlimax on your hands.

▶**Submitting the Article**—The publicity or public relations department of your company can be of great help to you in preparing articles. Enlist their aid for approvals and other matters. The following are some of the usual procedural requirements:

Text—Send original on heavy white bond paper, typewritten double- or triple-spaced with at least one carbon copy. Leave wide margins on all sides of the paper.

Length—Average length of a technical article is 2,500 words—10 to 12 typewritten (double-spaced) pages. Aim for this number. You are not, however, bound by it. Editorial budgets often provide enough leeway to give important subjects the space they need.

Graphs and Tables—Don't incorporate tabulations in text unless they're short and simple. Put them on separate sheets. Graphs must legibile. Identify and number each one, keying in with the text.

Approvals—Obtain all necessary company approvals before your article is submitted.

Photographs—Supply one set of glossy prints and one set of matching blueprints or whiteprints for all illustrations. Don't write on the backs of photographs, it may ruin the engraving.

Biography—Supply two or three paragraphs of professional biographical information. Also needed in many cases: a portrait photograph showing your full face. (Don't send a snapshot.)

Key point to remember, then, is: You can write well! And when your article appears in print you'll hear glowing comments like this: "I liked your article because I could read it and understand it."

NEW NSPE

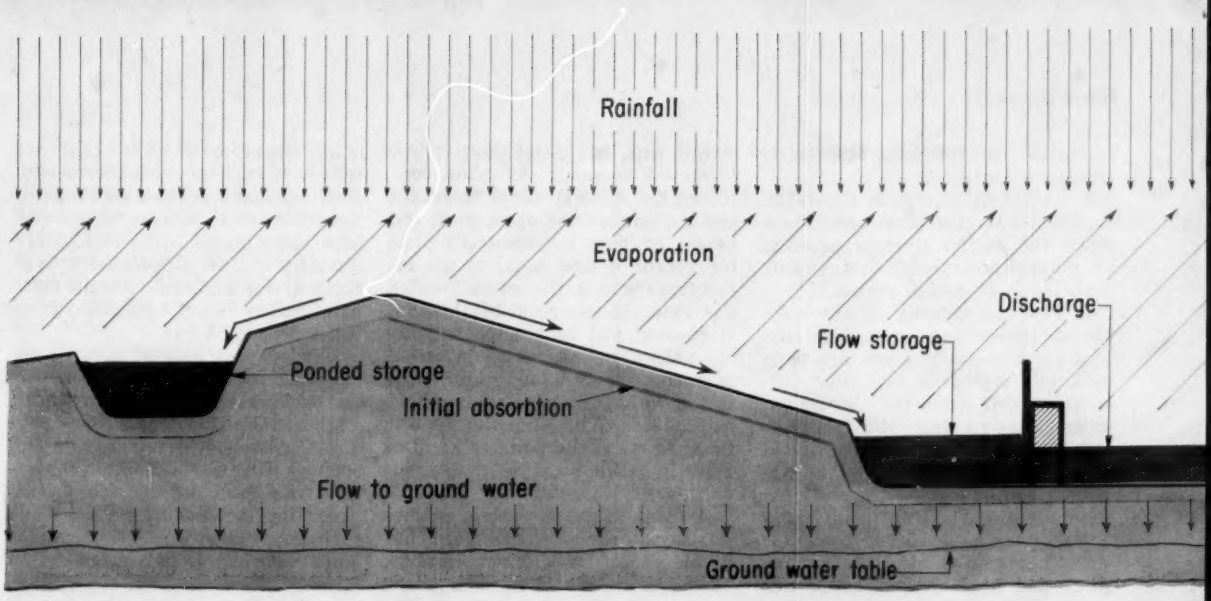
. . . *Policy on Unions*

The National Society of Professional Engineers has now adopted the following policy on the subject of professional responsibility vs. collective bargaining:

Collective bargaining for professional engineers is in conflict with the basic principles of a professional individual.

The individual responsibility and independent judgment required of a professional engineer are incompatible with the regimentation fundamentally inherent in unionization.

Collective bargaining divides the members of the profession into hostile groups and promotes discord among members of the same profession.



Control Storm and Flood Water

Careful analysis of drainage facilities for chemical plants provides adequate control of surface runoff at minimum cost.

GEORGE P. FULTON, Chemical Construction Corp., New York, N. Y.

Drainage is a minor item in any chemical plant construction or maintenance program. However, a bad drainage situation can add to site development costs. A poor drainage system often involves additional maintenance time and money.

Object of a drainage design is to limit flood levels and insure continuous plant operation at a reasonable cost by conveying, controlling and disposing rainfall, surface runoff and perhaps ground water within the confines of the site. Plant flood levels are influenced by the flow quantities, the hydraulic capacity of the system and the level in the waterway where runoff is discharged.

Flow quantities result from rainfall on the site itself and from normal overland flow intercepted by the plant. Unless the location is on a high point of ground, a plant physically interrupts natural drainage. Some area uphill of the plant may contribute runoff that must be accepted in the plant system or be routed around the property.

Rainfall and floods are variable factors so that some decision must be made to establish a storm or flood to use for design. Storms or floods will have values of rainfall intensity, duration and water levels that may occur at certain frequencies. Frequency can be expressed as the recurrence interval or the average time interval a value will be equalled or exceeded once in *T* yr. This does not mean that the intensity-duration value for a 10-yr. storm will occur once every 10 yr. but rather that at the end of an extended period, say 80 yr., the value will probably have occurred eight times. It is possible that these eight occurrences could have taken place within a 50-yr. or 20-yr. period.

Essentially, the drainage system is an insurance factor where varying degrees of flood protection can be supplied for varying costs. In some cases, it may be possible to provide complete drainage protection at nominal cost. In others, where high floods or rainfall rates are a common occurrence, costs may be prohibitive when designing for storms of low frequency or common occurrence.

When considering the extent of flood protection to be provided, cost of drainage facilities may be balanced against the effect of allowing some flooding of the site. Modifications of floor levels of buildings and raising elevations of some equipment foundations in many cases could permit flooding where the only bad effects are nuisance and cleanup.

Drainage is an integral part of the over-all plant planning where its design affects continuity and cost of production in the same way as design of process and structural facilities.

Use a Design Procedure

For adequate design of a drainage system, a logical analysis is

essential. The following steps provide a suitable basis:

1. Establish maximum desirable flood-water level on plant site. Then select the design storm frequency to determine rainfall rates and flood levels at outfall points.

2. Plot the routing of the runoff, collection and conveying pattern for the site and any drainage area intercepted by the site. Calculate runoff rates for the design storm. Design hydraulic facilities.

3. Decide whether intercepted flow should be included in plant system or routed around the site. Design outlet and outfall facilities.

4. Determine whether the plant must be isolated by dikes to simplify and to decrease cost of discharge works or to maintain flood levels within the site.

5. Prepare preliminary estimate of all drainage facilities. Examine general plant design for effect of higher flood levels and determine costs of modifications of plant to accept higher levels. Compare savings of drainage design for higher flood levels against plant modifications required.

6. Establish final drainage design for best economical results.

Where steep hydraulic gradients are available, drainage design can simply involve the few steps of outlining the drainage areas, sizing the system for the design storm and checking the facilities for storms of higher intensities. Where the drainage area is relatively flat and flood elevations at the point of outfall are generally high compared to the finished grade of the plant, more detailed studies and analyses are necessary.

Analyze Rainfall Runoff

Perhaps the simplest way to visualize the drainage pattern of a site is as a basin or reservoir. Suppose a flow of water were to be directed into an empty reservoir at a constant rate. At first contact, water will be absorbed into the ground. When saturation is reached, water will flow across the surface of the ground as well as downward into the ground water supply. The reservoir will then fill at a rate equal to the inflow rate minus the rate of loss to the ground water with a minor quantity evaporated into the atmosphere.

Water will not flow out of the reservoir until the spillway is topped and the initial flow at low depth will be small. As inflow continues, the spillway depth increases and the outflow increases until the height of flow is essentially that for a rate of flow equal to the inflow rate minus the ground-water flow rate. At this point equilibrium is reached and no change will occur unless the inflow rate is varied or until the subsurface water saturation builds up and decreases that rate of loss. The length of time it takes to reach the point of equilibrium is called the time of concentration.

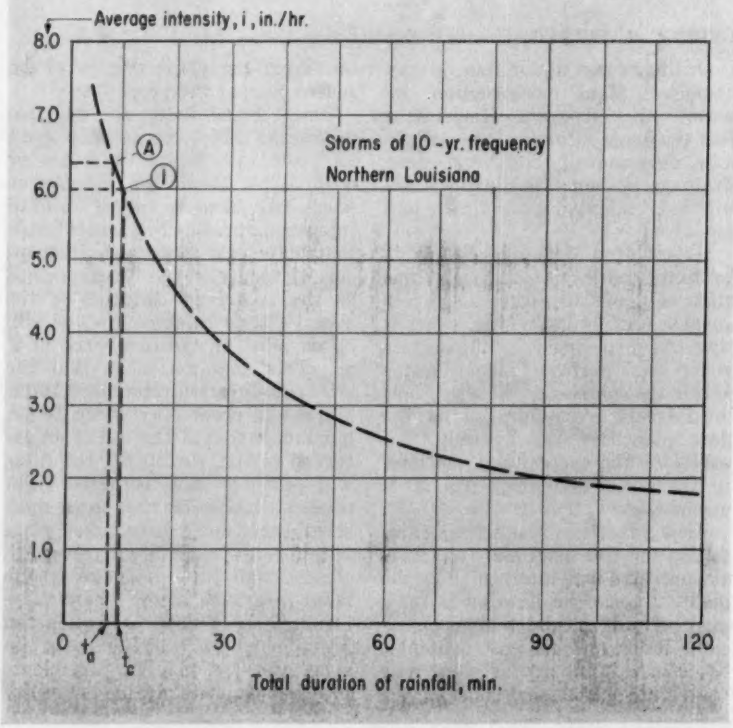
A plant drainage system is similar to the reservoir described, but divided into two distinct sections. The first is the flow from roofs, pavement and graded surfaces. The second is the flow in the collection and conveying pattern of ditches and pipelines.

Finished surfaces of a plant site such as buildings, equipment, foundations and paved areas are practically impervious. All the rain that falls here runs off except for a very small amount lost through evaporation. However, just as in gravity pipe and channel hydraulics, every quantity of flow establishes a fixed depth of flow and some storage must exist before runoff equals the rainfall rate.

Graded and sodded areas have higher friction factors. Hence for the same rates, depth of flow will be higher than for impervious surfaces. Also, some irregularities and hollows will exist adding to the storage. Depth of flow and storage affect only the time of concentration. The most important effect of the unpaved surfaces in a plant is that after initial absorption, some of the runoff will recharge the ground water supply and reduce the runoff rate by that amount.

Ditches and pipelines used for collecting and conveying storm flow in a plant are directly comparable to the reservoir. Earth ditches will

Use Local Rainfall Rates to Calculate Flow—Fig. 1

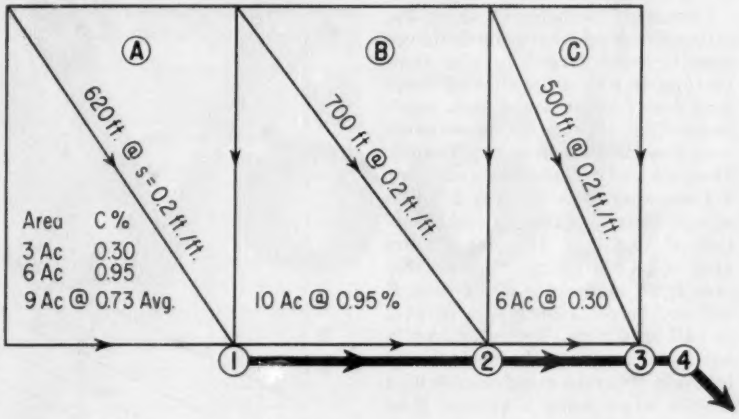


both store flow and allow recharging the ground water but paved ditches and pipelines are impervious and will only store flow.

Factors that influence the time of concentration or the time it takes to establish a fixed relationship between rainfall and runoff rates for any particular flow point in a plant drainage system are: (1) time of flow from contributing area most remote from the design point, (2) flow characteristics of surfaces and conveying channels or conduits and (3) storage in depressions.

Factors influencing the difference between rates of rainfall and runoff after time of concentration are: evaporation and perviousness of surface to ground water recharge.

Separate Plot Into Flow Areas for Computations—Fig. 2



Select Storm for Maximum Flow

As a basis for design, select the storm of probable rainfall intensity-duration that will occur or be exceeded once in T yr. In other words, a 10-yr. frequency storm will probably occur or be exceeded once every 10 yr. The same is true of the design flood establishing the hydraulic elevation at the point of discharge of plant flow. The elevation will be one probably not equalled or exceeded more than once every 10 yr.

The storm frequency chosen should be for a reasonable recurrence interval. It is not reasonable to select a storm of 50-yr. frequency for a plant expected to be obsolete or replaced in 15 yr. Hence, if a 20-yr. frequency design were provided, the system might be overtaxed once or twice in the life of the plant.

The design storm chosen is the factor that most influences size, extent and cost of drainage protection. Frequency of storm selected should have some relationship to the useful life of the plant and the value of the property for development beyond the plant life.

Rainfall intensity frequency data such as in the Dept. of Agriculture's "Publication No. 204" or in weather bureau literature can be obtained from the U. S. Supt. of Documents, Washington, D. C. After a design storm frequency is selected, prepare a rainfall curve as shown in Fig. 1 for the general area around the site.

Flood elevation and frequency information are available in the reports of the U. S. Geological Survey for major streams in many states. If the information cannot be found in the Survey, consult state and local highway and public works departments.

How to Compute Runoff

The formula for the rational method is expressed as:

$$Q = CiA$$

where Q is the peak rate of runoff, in./(acre)(hr.); i is rainfall intensity, in./hr.; A is area, acre; and C is surface characteristic allowing for rainfall to run off, %. Since a runoff rate of 1 in./(acre)(hr.) equals $1 \times 43{,}560/12 \times 360$ or 1.008 cfs., Q is expressed directly in units of cfs. The rainfall rate is the average intensity expected for the design storm lasting for a period equal to the time of concentration.

Consider a drainage area consisting of three parts which have the acreage and imperviousness shown in Fig. 2. Flows from each area are concentrated at points 1, 2 and 3 and carried from the site to point 4. The design using the rational method starts at the most upstream point. Before any water moves across a surface, initial absorption must take place. It is safe to assume five minutes for a 100% impervious surface to 10 min. where imperviousness is less than 50%.

Since area A is 73% impervious, initial absorption time is approximately 5 min. plus $5(0.95 - 0.73)/(0.95 - 0.50)$ or 7.4 min. To this initial time is added the time for the most remote drop of water to flow across area A to point 1. The rainfall rate used for Fig. 3 is obtained from Fig. 1 for the time of initial absorption. For this problem, the rate is 6.3 in./hr. for $t_o = 7.4$ min.

Overland time t_o from Fig. 3 is corrected for the average surface characteristics. Since one-third of area A is bare earth and two-thirds is impervious, the correction factor is proportional to the areas and equals 0.333×1 plus 0.667×0.5 or 0.66. Use this factor to compute t_o which now becomes 4.3×0.66 or 2.8 min.

Total time of concentration t_c equals the sum of t_o and corrected t_o or 10.2 min. Using Fig. 1 and t_c of 10.2 min., average intensity-duration of rainfall is 6.0 in./hr. for area A. Peak runoff of 39.6 cfs. is calculated from the formula $Q = CiA$. Results for all areas are given in Table II.

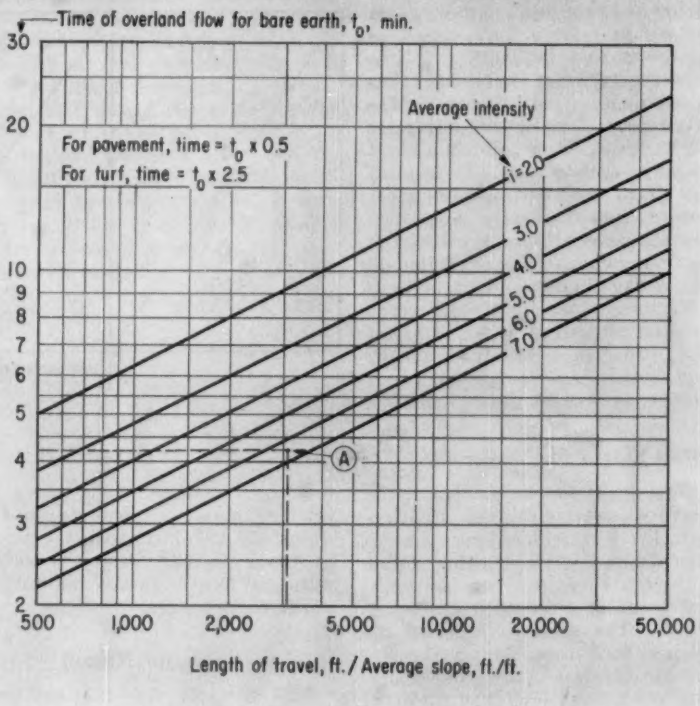
Note that the coefficient of imperviousness is the average for each area. The probable average rate of rainfall decreases as the time of concentration or total duration of storm period increases. Time of concentration and resulting rainfall rates change only as the contributing drainage area gets larger. Hence, where no flow is added the design flow remains constant.

Increments of time of concentration between flow collection points are determined by the velocity in the carrying conduit or channel and the length of flow path. If a 500-ft. long pipe is used between points 1 and 2 to carry the flow at a ve-

locity of 2 fps. for the proposed slope, the increment of time is 500/2 or 250 sec.

Care must be taken in using the rational method where one drainage area is much larger in size than average or where the time of overland flow for the area takes much longer than average. Suppose overland flow time for area *B* is 15 min. Then time of concentration at point 2 from area *B* is 15 plus 5 or 20 min. compared to time of concentration of 14.4 min. at point 2 from area *A*. Controlling time in this case is 20 min. since all of area *B* will not be contributing to point 2 in 14.4 min. time. This condition is not usual but a quick check should be made to avoid overdesign which results when using a shorter time of concentration.

Chart Gives Time of Overland Flow for Bare Earth—Fig. 3



Consider Drainage Conduits

A drainage system for a plant is classified as either an open or closed system depending on whether flow is carried in a surface channel or buried pipeline. If runoff is intercepted by roof gutters, paved area inlets or even by roadway ditches into basin inlets and then carried by pipeline, the system is closed. An open system is one where the runoff is carried in open ditches or channels.

A plant may be designed for either open or closed drainage or both if economic considerations of cost and maintenance so dictate. The open system will carry a much greater flow at a higher hydraulic elevation and at a lower construction cost than comparable underground lines. Pipelines require protective cover against impact. A closed conduit requires a steeper gradient than an open channel of similar cross section to carry the same flow. This characteristic will depress the flow line at a faster rate for a pipeline than for the equivalent ditch.

In some cases, maintenance of ditches for weed control, sediment removal or erosion repair have proved costly enough to prohibit use of the open system. The open system with roadway ditches and conveying channels requires wider areas which might be for other purposes. However, if maintenance and property costs do not prove unreasonable, the open system is the most economical method to carry flow. The open system has the additional advantage of being completely visible and accessible for required maintenance.

Relative Imperviousness—Table I

	C
Roof surfaces	0.95
Concrete pavement	0.95
Asphalt pavement	0.95
Gravel roadways and walks	0.50
Unpaved earth surfaces	0.10–0.30
Turf or sodded areas	0.05–0.25
Wooded or forest area	0.01–0.20

Where more than one value is given, imperviousness depends on whether ground is dry, water-soaked or frozen.

Isolation of Plant Site

When it proves advantageous the plant site should be isolated or separated from normal runoff from adjacent land or from the general flood in the area. If the plant layout has no barrier such as a perimeter road to block the outside overland runoff, analysis should be made by means of the rational method to determine the runoff both including and excluding the outside flow. Outside areas will always increase flow because either part or all of it contributes to the runoff within the site.

The system should be designed, first, to include the additional flow; and then to route the outside flow around the plant site in a ditch or channel to the point of junction with the plant discharge. When overland flow is intercepted, natural sheet-form flow is concentrated. It is an obligation in constructing a new plant, to protect adjoining properties from harmful flood damage resulting from changes that the plant may make in natural runoff. Intercepted runoff must be conveyed to a natural waterway or public road ditch. In no instance should concentrated flow be spilled or backed up on other properties.

The decision of separating intercepted overland flow from the plant system or accepting the runoff is decided by the most economic solu-

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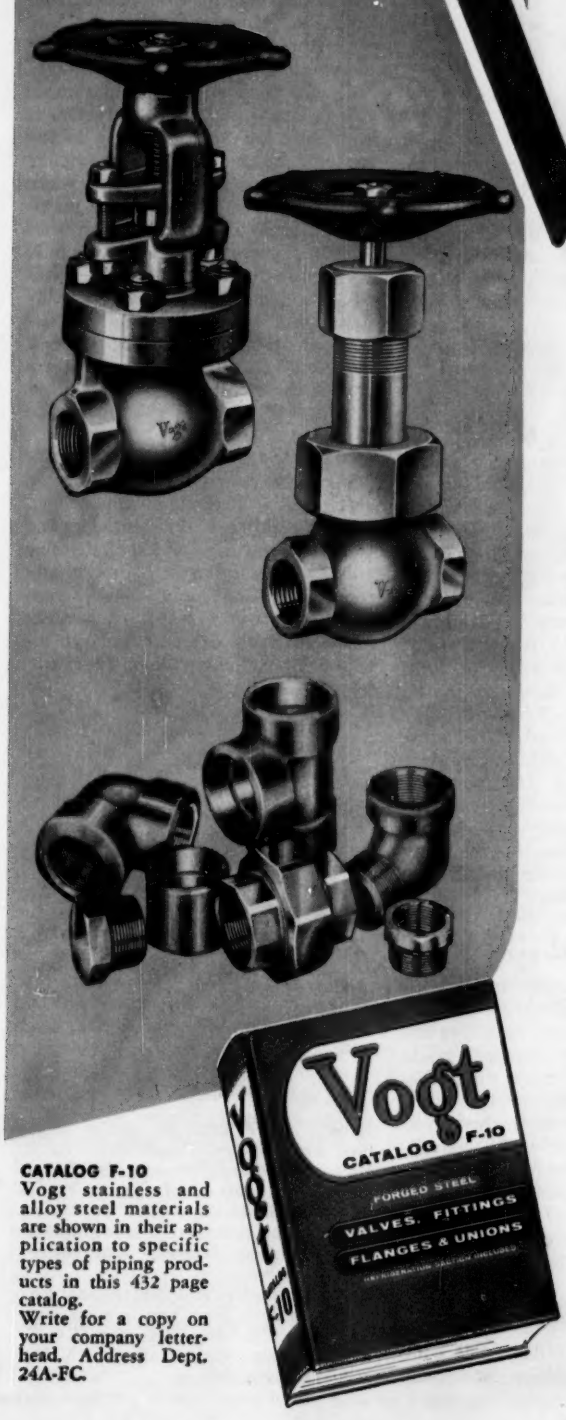

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How to Compute Runoff Rates for Problem—Table II

Point	Area, Acre	C	C×A	ΣCA	Time of Concentration t_a	t_b	t_f	t_c	i, In./Hr.	Q, CFS.
1	9	0.73	6.6	6.6	7.4	2.8	...	10.2	6.0	39.6
2	10	0.95	9.5	16.1	...	...	4.2	14.4	5.2	84.0
3	6	0.30	1.8	17.9	...	...	2.4	16.8	4.9	88.0
4	..	....	...	17.9	...	...	...	....	4.9	88.0

tion. However, it is best to exclude this additional flow by routing the flow in a channel or ditch around the site since future development of adjoining lands is not predictable. Increasing the imperviousness of intercepted areas will increase runoff rates.

If the plant design must keep the flood level within the plant lower than the normal flood level in the general locality, pumping is required and the plant must be completely isolated. Such separation is accomplished by setting grades for perimeter roads or dikes at a nominal height of 6 to 12 in. above the design flood.

Disposal of Plant Runoff

The two factors controlling disposal of accumulated storm flow from the plant are the hydraulic capacity of the discharge culvert or pipeline and the difference in hydraulic level between the maximum design elevation within the site and the flood elevation in the receiving waterway. Where outside flood levels have always been below the desirable plant water heights, proper hydraulic facilities will maintain the design condition.

However, if the flood elevations are above the plant design figure at intervals more frequent than wanted or even at extreme heights infrequently, the plant should be isolated and the runoff pumped. The decision to isolate the plant site and pumping runoff is again one of frequency, consequences to plant operation and cost.

Pumping and Storage

Providing storm-water pumps with capacity equal to the maximum runoff rate would be prohibitive in cost in most cases. It is more reasonable to provide some storm flow storage or detention within the plant site with pumps of lesser capacity. Storage may be available in the plant ditches where an open system is used or can be provided by excavating a reservoir specifically for storm flow.

Where lagoons are used for plant wastes some depth could be used for storm flow retention but in the case of ditches or lagoons, there are maximum design water elevations to consider. Hence, storage is available only above those levels. In a separate storage basin the entire volume can be used.

Consider a plant where 1,000 lineal ft. of ditches carry storm flow and it is possible to allow the water to rise 6 in. above the design level without exceeding the maximum design elevation. Neglecting ditch side slopes, available storage is 500 cu. ft or about 3,700 gal. Maximum runoff rate for design is 1.7 cfs. (750 gpm.) for a time of concentration of 10 min. for total runoff of 7,500 gal. Required pumping capacity equals (7,500—3,700)/10 or 380 gpm. instead of 750 gpm.

If the benefit of ditch storage is minor in reducing the pumping rate, a separate detention reservoir should be considered with cost of the reservoir versus the resulting saving in the pumping installation deciding the final design.

Use Drains for Ground Water

Where high ground water seriously affects foundation bearing values or where plant facilities are located below the finished grade level, underdrains may prove desirable to lower the water table. For successful use of underdrains, the hydraulic profile of the conveying system must be low enough to carry away the ground water. Usually it is mandatory that a closed system of conveyance be used where underdrains are installed.

Check for Maximum Flows

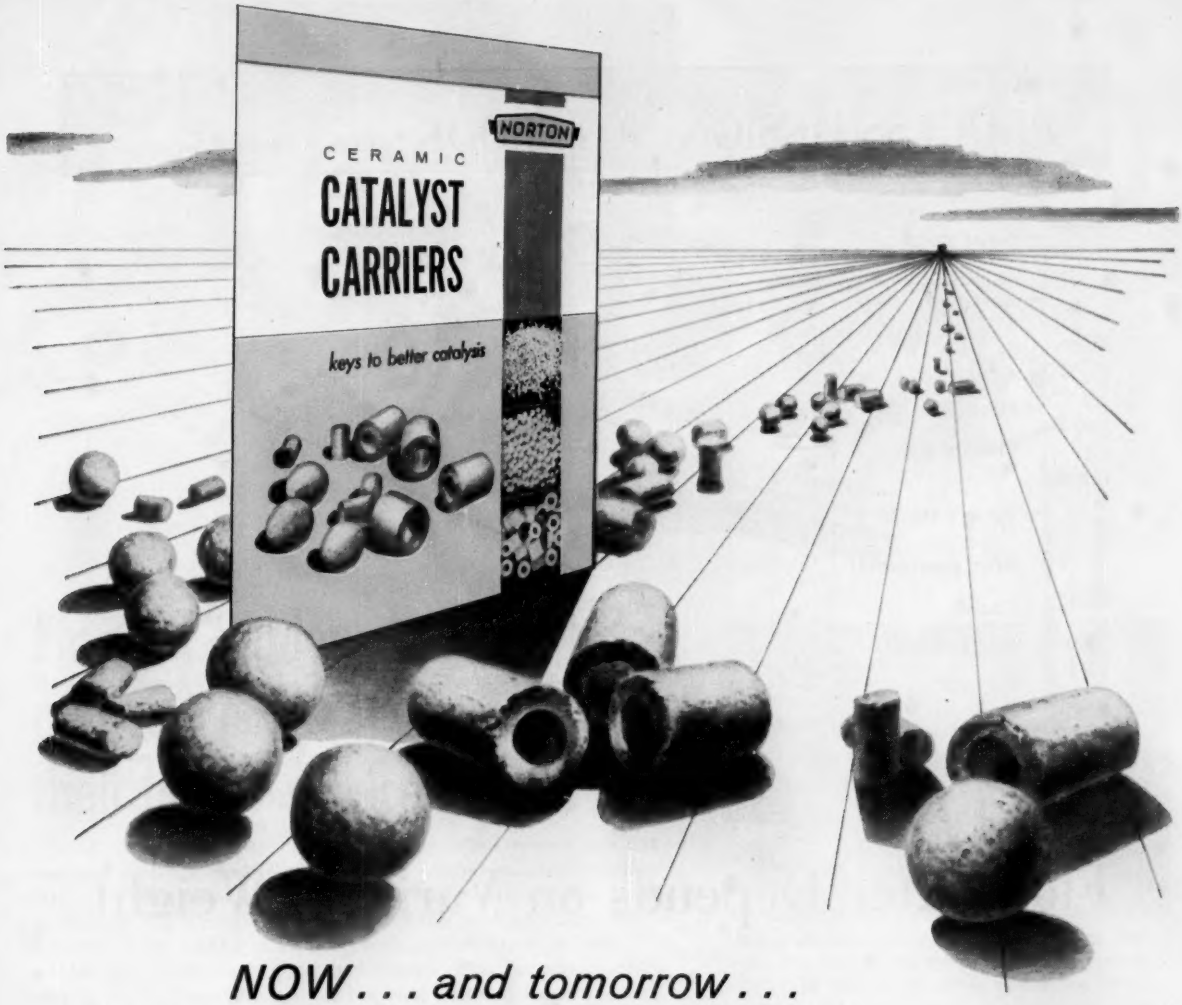
After a drainage design is completed and all facilities have been sized, a final check should be made to study the effects of a maximum rainfall or flood. The maximum storm of record is rarely used for design since recurrence possibility of such storms is small. Choice of the design storm is based on probabilities. However, when dealing with the forces of nature almost anything is possible.

In the final check the maximum rainfall rate and flood of record is used as a basis for analysis of the system. Hazard and major damage are the major points of issue when measuring the effects of the maximum storm. This check determines whether excessive velocities could scour out foundations or whether the flood level could irreparably damage a boiler or some process equipment. Where electric-powered pumping is used to dispose of storm water, the effect of a power failure on plant flood levels should also be considered.

Here, the intent is not to modify the system to handle the maximum storm but to prevent destruction of valuable process installations and to avoid harm to personnel. The rule is to design the drainage system to dispose of storm flow of reasonable occurrence but to protect the plant from extreme damage incurred by runoff and flood from any possible storm.

GEORGE P. FULTON is senior engineer for Chemical Construction Corp. He has wide experience in the design of complete water facilities for chemical and industrial plants. His work includes the design of cooling water, process water, drainage and sewerage facilities.

Fulton is a licensed Professional Engineer in New York and is a member of the ASCE. He holds the B. C. E. degree from City College (N. Y.) school of engineering.



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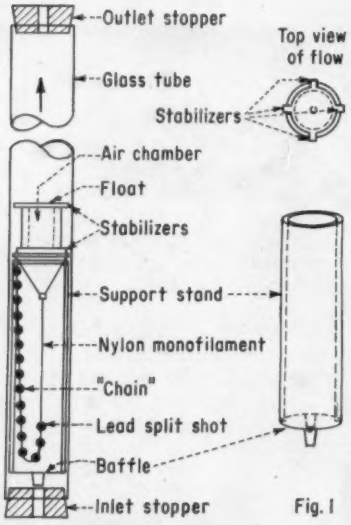


Fig. 1

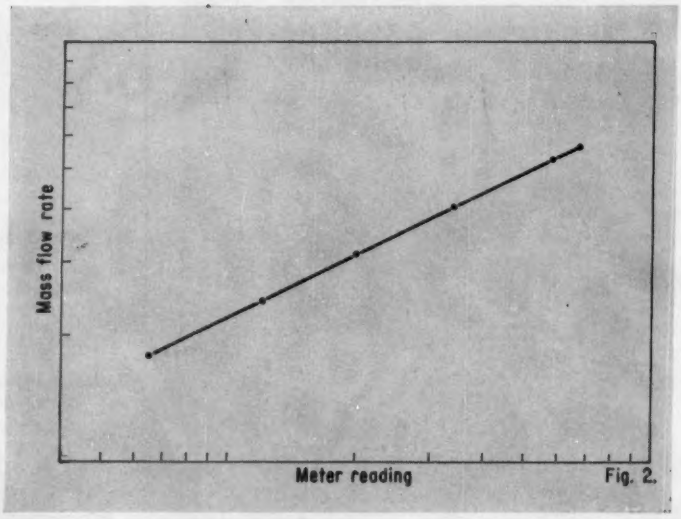


Fig. 2.

Flowmeter Depends on Variable Weight

Although similar to a rotameter in appearance, this meter is easier to build for lab and pilot plant use since it needs no tapered tube.

Wilfred F. Mathewson, Jr., and Julian C. Smith

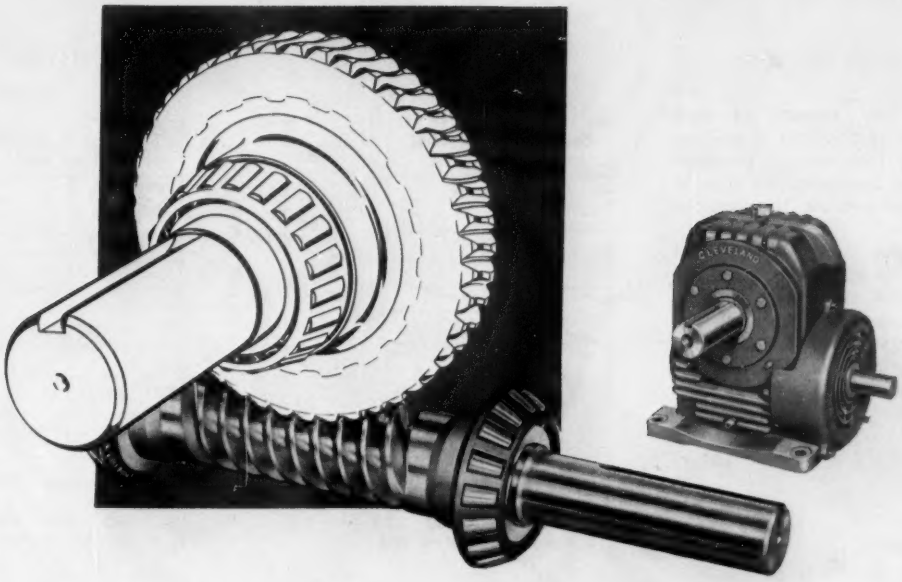
School of Chemical and Metallurgical Engineering, Cornell University, Ithaca, N. Y.

Sketched above in Fig. 1 is a simple design of flowmeter which is similar in general appearance to a conventional rotameter but with a difference in principle. In this meter the apparent weight of the float varies with the meter reading. In the rotameter, the flow area past the float varies with the reading. This meter is cheap and easy to build, unlike the variable-area rotameter, and it also has some advantages over the orifice meter.

The meter consists essentially of a vertical glass tube of constant diameter containing a float which rises higher as the flow rate increases. The flow area is constant throughout the tube, but the apparent weight of the float (that is, the actual weight less the weight of the displaced fluid) is made to vary by having it support a lesser or greater part of a fixed length of chain.

One end of the chain is connected to a fixed support near the bottom of the tube, while the other is attached to the float. Thus, when the float rests on the support shown, the chain hangs loosely in a loop. When the float is at its upper limit of travel it supports almost the full length of chain so that, from the position of zero flow, to that of maximum flow, the amount of chain supported by the float varies from a small part of the total chain, to almost all of it. The relation between float height and flow rate is found by calibration.

The particular model tested was made of a glass tube 0.87 in. in diameter and 16 in. long. We had the float machined from Lucite, with an air chamber so that its over-all density was less than water. The "chain" in this case was a nylon monofilament 7½ in. long, on which 22 split lead shot, each 0.15 in. dia., were crimped as closely together as



Flamatic-hardened worms help give Cleveland Speed Reducers their longer service life . . .

On all Cleveland Speed Reducers, alloy steel worms are cut integral with the shaft and accurately ground to a high surface finish on both thread flanks. Shaft extension diameter is especially large to permit increased overhung load capacity. Heat treating is by means of an acetylene-oxygen flame at 3300° F. —exclusive with Cleveland-made worms. This provides a high degree of hardness throughout the entire thread thickness and well below the worm's root diameter—(See etched worm cross-section).

This new worm hardness pattern gives maximum thread strength and resistance to wear without sacrificing the advantage of a medium-hard tough core. Furthermore, the pattern is carried out in the worm shaft extension past the oil seal wearing surface to prevent the shaft being worn and damaged by its oil seal.

Mated with Cleveland's high density centrifugally cast bronze gears, the result is increased wear resistance—much longer trouble-free service life.

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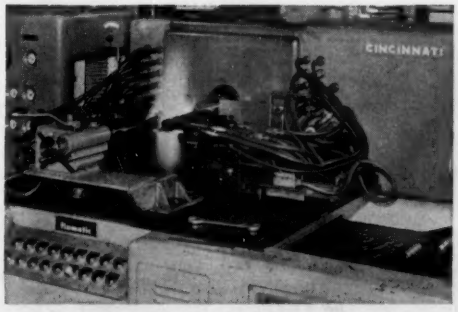
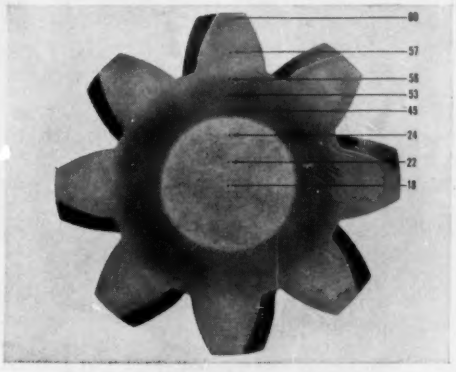


Worms are Flamatic-hardened in the Cleveland Plant (above) to give them the typical Rockwell "C" hardness pattern as shown in the etched cross-section (below).



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Speed Reducers

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Eaton Manufacturing Company
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possible. The amount of shot supported by the float at no-flow was made just enough to offset the float's buoyancy so that it would just rest on the support stand.

The meter worked equally well with liquids and gases, giving a straight-line calibration on log-log paper as shown in Fig. 2. The curve is similar to that obtained with an orific meter. It would be possible to produce a linear variation of flow with meter reading, if desired, by using a non-linear spacing of the lead split shot on the "chain."

There are several variables in the design of the meter which permit a wide selection in meter range and in the variation of flow rate with meter reading. These variables include the densities of float and chain, the diameters of the tube and float, the lengths of tube and chain, and the distribution of weight along the length of the chain.

Although the meter must be calibrated, it is instructive to consider the factors that enter into its performance. When flow starts through the meter the float rises until the drag on the float exactly balances the apparent weight of the float plus that part of the chain it is supporting. From this fact and the definition of the drag coefficient it becomes apparent that:

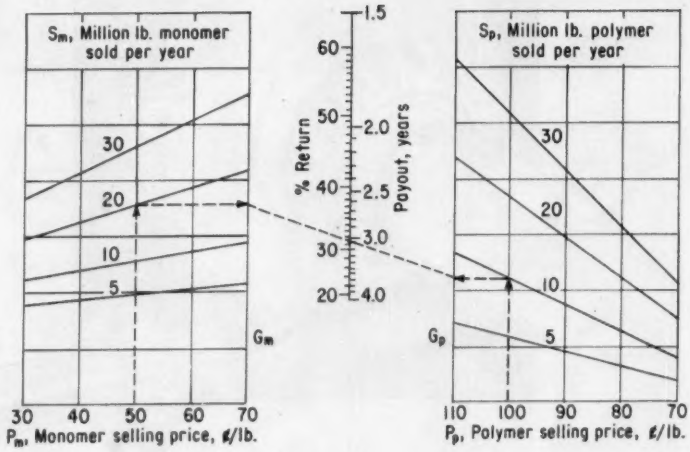
$$W = \sqrt{K/C_D}\,\sqrt{M_f + M_c}$$

where $K = 2g_c\rho A_t^2/A_p$. The terms are as follows: W is mass flow rate; g_c is the gravitational conversion constant, 32.2 ft./sec. ^{2}; A_t is the cross-sectional area of the tube, less that of the chain; A_p is the projected cross-sectional area of the float; C_D is the drag coefficient (assumed constant); M_f is the apparent weight of the float; and M_c is the apparent weight of the supported part of the chain.

In the meter tested, the distribution of weight on the "chain" was uniform, that is, $M_c = K'R$, where K' is a constant and R the meter reading. We could have produced a linear variation in R with changes in W if the chain had been constructed so that:

$$M_f + M_c = K'' R^2$$

where K'' is another constant.



Graph Shows Plant Economics

Ron Carstens

Process Engineer, Mfg. Dept., Continental Oil Co., Ponca City, Okla.

Shown above is an example of a method of plotting economic data on multiple products which is easy on both the engineer who uses it, and on his management who must read it. More variables can be represented on such a chart than with conventional graphs. They are simpler to make and to read than ordinary nomographs.

The example presented above is that of a plant producing and selling both the monomer and the polymer of a certain plastic. It is representative of the presentation method for a dual-product plant. As you will see, the chart illustrates the effect of four variables on investment profitability in a manner which makes it easy to see the effects of any one variable. The basic type of chart, with a graph representing the variables for each product, can be expanded to more than two products with the use of additional graphs and index lines.

However, the scheme's usefulness as compared with the original method, is somewhat impaired when more than two products are considered.

The graph is constructed with the following equations in the manner shown below for a plant which makes the monomer and polymer of a certain plastic. The basic equation is:

$$\text{Payout} = \frac{\text{Investment}}{\text{Annual cash flow}} \qquad (1)$$

Using appropriate symbols, this expression can be expanded and rearranged in the following form for a 50% tax rate:

$$Y = \frac{2I}{S_m(P_m - V_m) + S_p(P_p - V_p) - F_t + D} \qquad (2)$$

If we define a new variable $G =$

Nomenclature

Y	Payout time, years.
P	Selling price, $/lb.
V	Fixed unit cost portion of the unit manufacturing cost, e.g., raw materials and utilities, $/lb.
F	Fixed annual cost portion of the unit manufacturing cost, e.g., maintenance, overhead, etc., $/lb.
S	Annual product sales, lb./yr.
D	Annual depreciation, $/yr.
I	Capital investment, $.

Subscripts

m	Monomer.
p	Polymer.
t	Monomer and polymer.

Fairbanks Nº 1

a scale, our first one.
an imagination of iron, brass, copper and lead,
fashioned in a New England workshop.
inanimate.

but it spoke—
a different kind of language,
of pounds and ounces and fractions thereof
and it spoke only the truth.

it felt—
the roundness of grain, the smoothness of marble,
the sweetness of candy and the authority of gold.

it heard—
the sound of life, babies newborn
it cradled them and recorded their growth
until pounds and ounces were replaced
by years and months.

it traveled—
by packet boat down the Mississippi,
by clipper ship to England,
The Sandwich Isles, the Indies,
South America and China.
better known throughout the world
than anything else made in America.

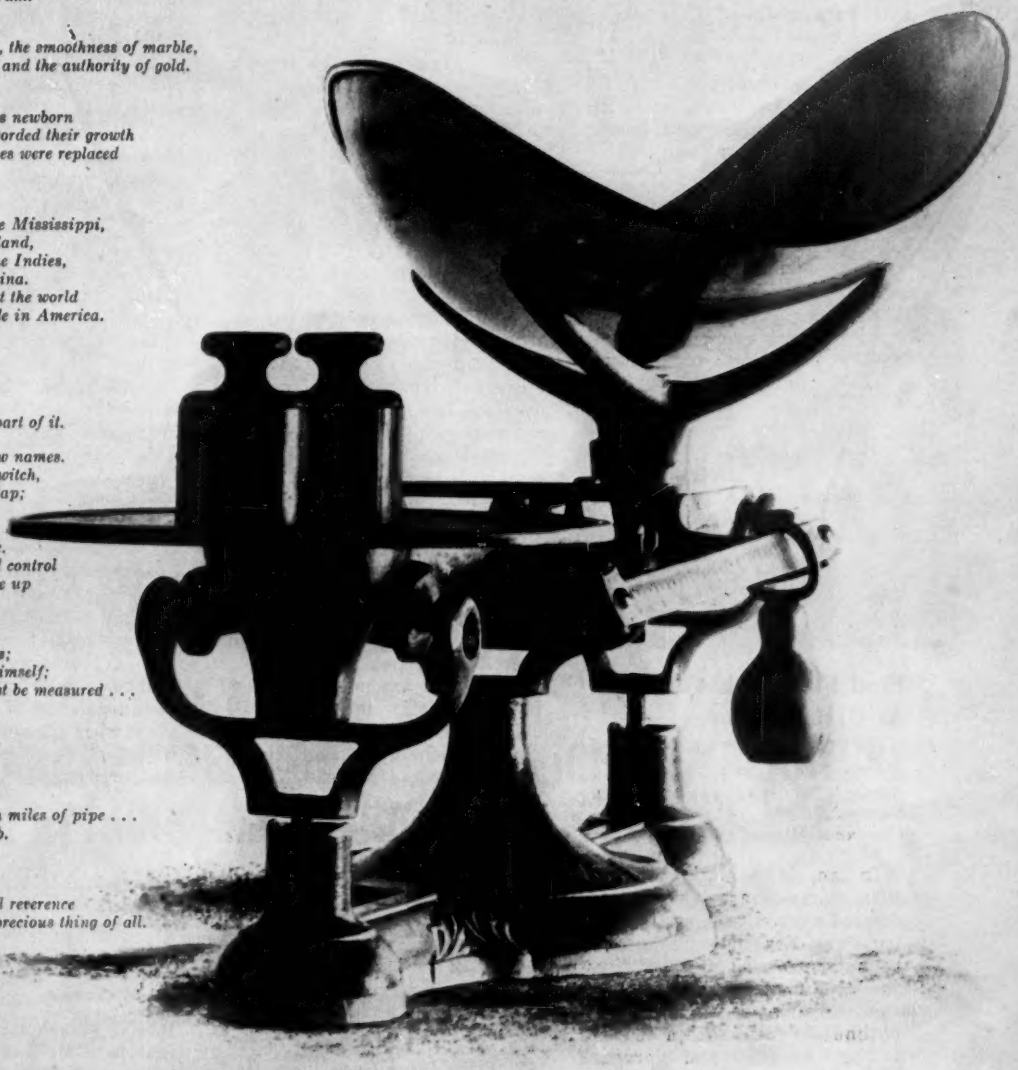
it was relied on
by farmers, merchants,
scientists and doctors.
it witnessed history;
influenced it and was part of it.

its descendants have new names.
floaxial dial, mercoid switch,
reed switch and cotton lap;
remote control,
printomatic,
electronic and levetronic.
all serve to evaluate and control
the substances that make up
the universe.

raw materials
or manufactured articles;
things unseen or man himself;
all have weight and must be measured . . .
our scales do the job.

and the new challenge—
weight in motion . . .
freight trains in transit,
trucks too busy to stop,
liquids coursing through miles of pipe . . .
our scales will do the job.

but this was our first—
Fairbanks No. 1
and we hold it in special reverence
for it weighed the most precious thing of all.
it weighed an idea.



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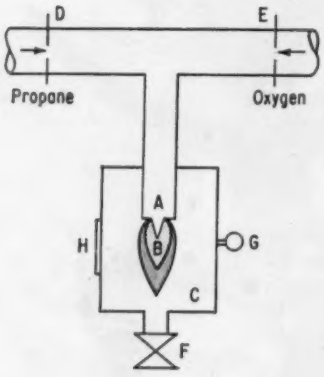
$S(P - V)$ for each product, we can rewrite Eq. (2) as follows:

$$Y = \frac{2I}{G_m + G_p - F_i + D} \quad (3)$$

For each product (e.g., the monomer and polymer) we construct simple graphs of G vs. P, with parameters of S (V being known), as shown in the diagram on p. 138.

In any economic study I, F_i and D are constants and are known for a particular plant. Hence, the only variables in Eq. (3) are Y, the payout, and G_m and G_p, the ordinates of the two graphs previously constructed. Set up the two product graphs with the ordinates aligned as shown and calibrate the payout line midway between them by means of Eq. (3), relating Y, G_m and G_p.

The annual rate of return can be computed from the payout and included on the payout scale as shown, if desired.



Find Flashback Velocity At High Pressure

Joseph B. Conway
Aircraft Nuclear Propulsion Dept.
General Electric Co.
Cincinnati, Ohio.

In an investigation dealing with flame characteristics, we devised a novel, safe and convenient way for measuring flashback velocities at elevated pressures. This method applied to the propane-oxygen system is outlined in the diagram above.

The oxygen and propane streams are metered and fed to the torch A where they burn to produce a stable flame at B in chamber C. The throttling orifices D and E in the propane and oxygen lines are sized so that the stoichiometric composition (five parts of oxygen by volume to one part of propane) will be obtained for any given back pressure on the orifices.

The back pressure is adjusted to operate the orifices in the "choked" condition, which causes the mass flow rate of each gas to be a function only of the upstream pressure on the orifice—assuming, of course, that the upstream temperature remains constant, as do the orifice dimensions.

Under these conditions the mass flow rate will remain unchanged even when the chamber pressure is increased by closing down on the throttling valve F. This is a familiar characteristic of throttled orifices and remains true as long as the chamber (downstream) pressure does not exceed the critical pressure. For propane and oxygen, the critical pressure ratio is about 0.54. Therefore, at 100 psia. back pressure, the chamber pressure can be increased to 54 psia. without changing the mass flow rate of either gas.

Constant mass flow, of course, implies a constant volumetric flow rate expressed at standard conditions. However, as the chamber pressure is increased, the volumetric flow rate measured at the chamber pressure decreases, as does the linear velocity through the torch tube. In view of the constancy of mass velocity, the throttling valve F may be closed down gradually, increasing the chamber pressure as read on gage G, without altering the desired stoichiometric conditions, provided upstream pressure is held constant.

As the chamber pressure is raised, the linear velocity decreases in the torch tube, even though mass flow rate is unaffected. This will eventually produce flashback, which can be observed through the sight glass H in chamber C. At this point the chamber pressure can be used to calculate the linear velocity at flashback.

To find the flashback velocity at higher pressure the orifice back pressure can be increased to yield higher propane and oxygen flow rates—still stoichiometric—and higher linear velocities.

In propane-oxygen, the linear flashback velocity was found to be independent of pressure up to a chamber pressure of 30 psig., with turbulent flow conditions in the torch tube.

Coming May 30: Successful Seal for Float Gages

By W. E. Robertson, Winner of the March Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks. Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.

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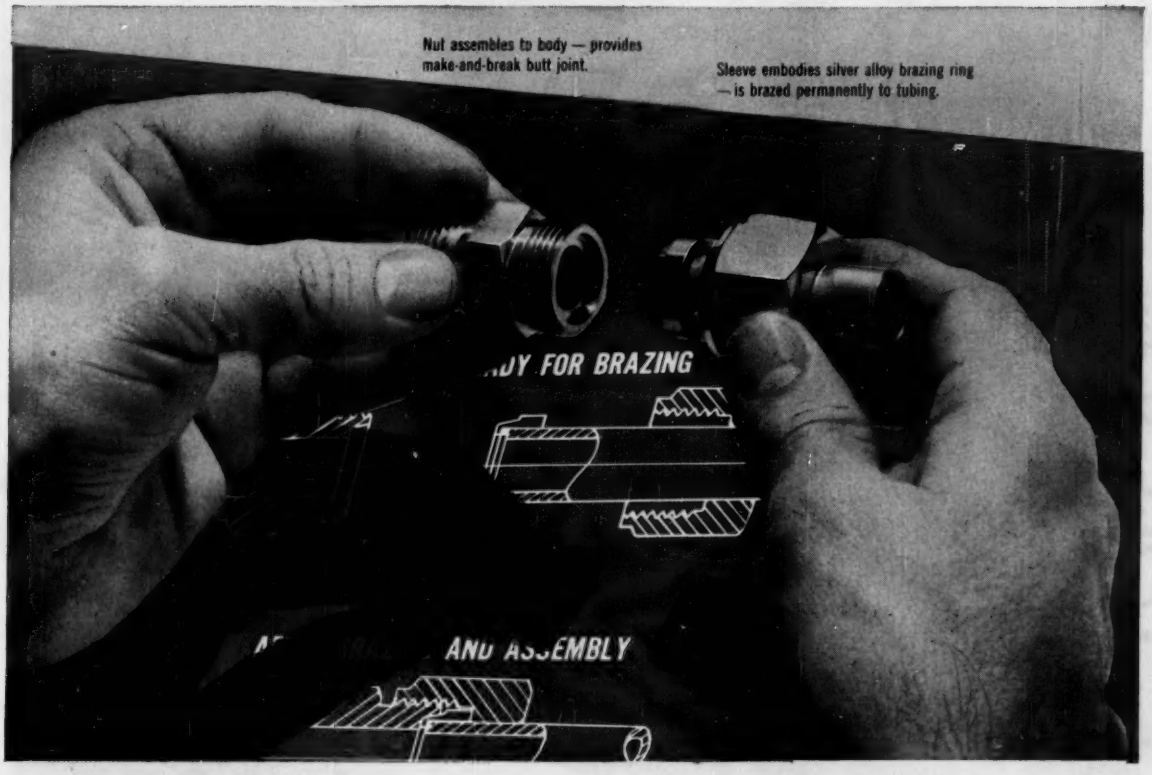

Nut assembles to body — provides make-and-break butt joint.
Sleeve embodies silver alloy brazing ring — is brazed permanently to tubing.
FOR BRAZING
AND ASSEMBLY

NEW BRAZE-SEAL TUBE FITTING

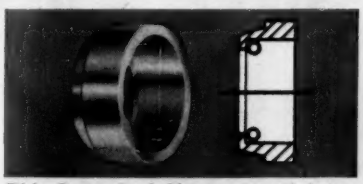
WITHSTANDS SUPER-PRESSURES, HIGH TEMPERATURES . . . RETAINS MAKE-AND-BREAK CONVENIENCE

Until Imperial Braze-Seal came along, engineers could not specify an economical make-and-break fitting for tubing circuits involving super-pressures and high temperatures. Applications like these called for welded connections. But now Braze-Seal offers high reliability, even under extreme pressures. (See chart below.)

MAXIMUM DESIGN PRESSURES (PSI) FOR BRAZE-SEAL FITTINGS

Tube O.D.	316 Stainless	Carbon Steel
3/8"	64,000	48,000
1/2"	62,400	46,800
9/16"	61,600	
5/8"	61,600	46,200
3/4"	60,000	45,000
7/8"	56,000	42,000
1"	52,000	39,000
1-1/4"	48,000	36,000
1-1/2"	44,000	33,000

Application of the following safety factor is recommended: 4 to 1, for sizes up to ¾" O.D.; 6 to 1, for sizes ⅞" to 1½" O.D.



This Braze-Seal Sleeve, containing a silver alloy brazing ring, is the key to the performance of the Braze-Seal Fitting. It assures a joint that will withstand these extreme pressures because it is permanently brazed to tubing. Yet the fitting provides the convenience of a make-and-break butt joint, as illustrated, and is extremely easy to assemble.

Reducing Sleeves Provide Versatility

Can be furnished to reduce any size Braze-Seal tube end to any specified tube size. Extremely convenient on tees, for example, where any size tubing can be connected to the same tee body. Also, the same body may be used for making up flareless Hi-Seal fitting joints.

Imperial Braze-Seal Tube Fittings can be furnished in steel or stainless steel.

Check the outstanding features of Braze-Seal for yourself. Send for a sample fitting. See how Braze-Seal can help you solve the most difficult problems in super-pressure and high-temperature tube circuitry.

IT'S IN THE BOOK

Braze-Seal Fittings are covered in Imperial's new Hi-Seal Catalog — the most comprehensive coverage available on the subject of fittings, a hard-working handbook for engineers. Send for your copy today.

THE IMPERIAL BRASS MANUFACTURING CO.
Dept. CME-50, 6300 West Howard Street
Chicago 48, Illinois 8-60

CE COST FILE

No. 28: Labor Factors; A.C. Motor Starters

E. Wayne Michel, Ethyl Corp., Baton Rouge, La.

The following tabulations give man-hours for mounting and connecting a.c. motor starters. Units include connections at motor and testing for direction of rotation but no wire or conduit. They are based on experience in Gulf and West Coast areas. Units represent work of an average journeyman.

Manual

Full Voltage

Maximum Rating	Mounting: Brick	Concrete	Steel
1 hp./110 v.–1½ hp./220 v. (single phase)	3.4	3.7	3.7
1½ hp./110 v.–3 hp./220 v. (single phase)	4.0	4.5	4.5
2 hp./220, 440 v. (2- or 3-phase)	4.3	5.1	5.1
5 hp./220 v.–7½ hp./440 v. (2- or 3-phase)	5.1	5.8	5.8

Notes: 1. For flush mounting, increase units 10%.
2. For cast iron boxes, increase units 20%.
3. For 2-phase, 4-wire, increase 3-wire units 10%.

Reduced Voltage A.C. Compensators

Maximum Rating 60 cycle, 2- or 3-phase, 3-wire	Mounting: Brick 220 v.	Brick 440 v.	Concrete 220 v.	Concrete 440 v.	Steel 220 v.	Steel 440 v.
10 hp.	8.2	8.2	9.0	9.0	9.0	9.0
15 hp.	10.5	9.0	11.2	10.5	11.2	10.5
25 hp.	11.7	10.5	12.4	11.2	12.3	11.1
30 hp.	12.7	11.2	13.5	12.0	13.2	11.7
40 hp.	14.2	12.0	15.0	12.7	14.4	12.3
50 hp.	15.0	13.5	15.7	14.2	15.0	13.5
75 hp.	16.5	14.2	17.2	15.0	16.2	13.9
100 hp.	21.0	15.7	21.7	16.5	18.7	15.0

Notes: 1. For 25 cycle, increase units 10%.
2. For 2-phase, 4-wire, increase units 10%.

Magnetic

Full Voltage (includes push button)

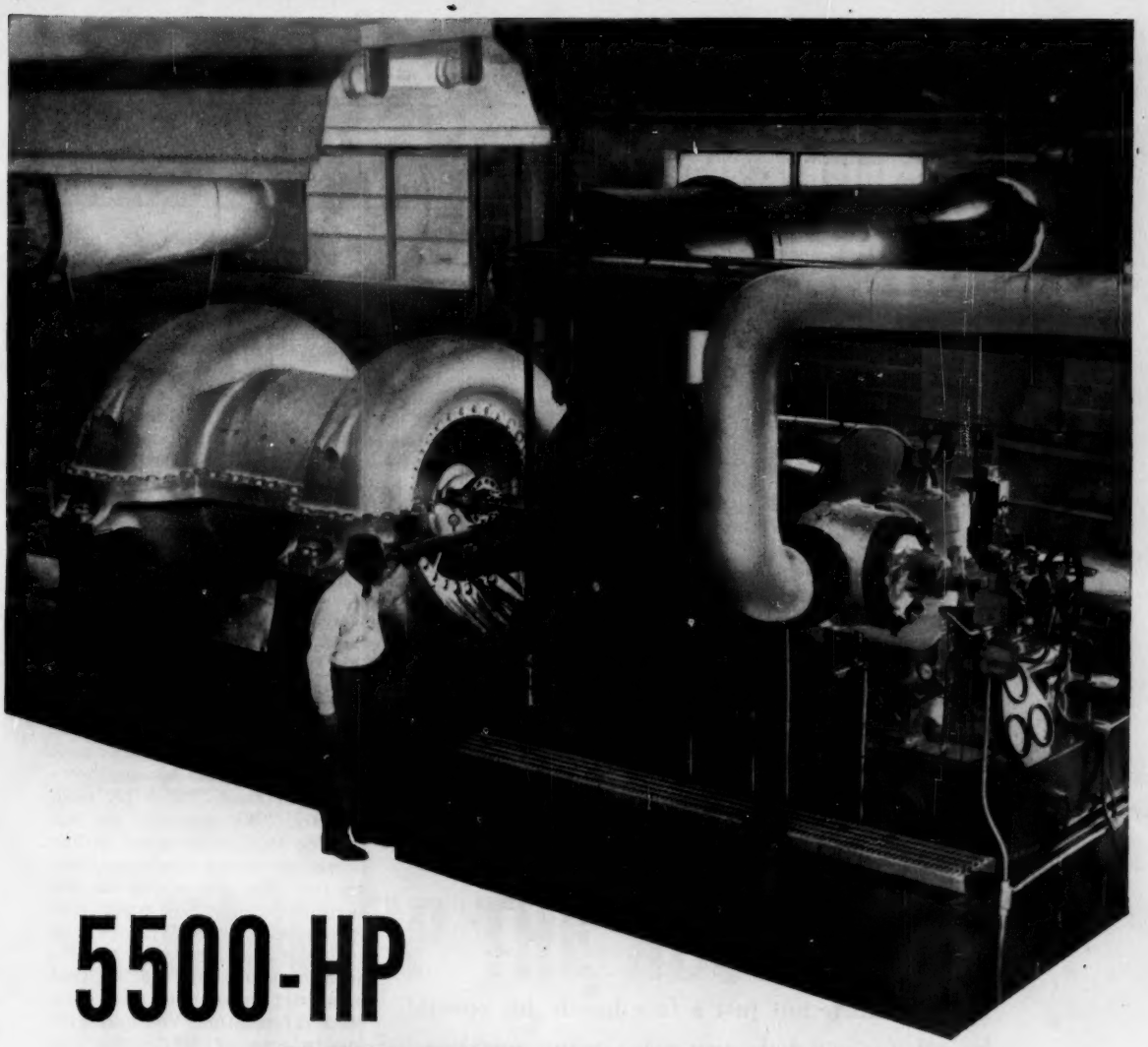
25 or 60 cycle, 2- or 3-phase, 3-wire Size	220 v.	440 v.	Mounting: Brick	Concrete	Steel
0	2 hp.	2 hp.	6.7	7.9	7.9
1	5 hp.	7½ hp.	8.2	9.4	9.4
2	15 hp.	25 hp.	10.2	11.2	11.2
3	30 hp.	50 hp.	12.0	13.2	12.9
4	50 hp.	100 hp.	15.7	16.5	15.7
5	75 hp.	125 hp.	25.5	27.0	25.5
5	100 hp.	200 hp.	30.0	31.5	30.0
6	200 hp.	400 hp.	48.0	51.0	45.0

Notes: 1. For reversing starters, increase units 5%.
2. For combination starters, increase units 5%.
3. For 2-speed starters, increase units 15%.
4. For 2-phase, 4-wire, starters, increase units 10%.
5. For cast iron boxes, increase units 15%.
6. For oil-immersed starters, increase units 25%.

Reduced Voltage (includes push button)

Maximum Rating 60 cycle, 2- or 3-phase, 3-wire	Mounting: Brick 220 v.	Brick 440 v.	Concrete 220 v.	Concrete 440 v.	Steel 220 v.	Steel 440 v.
10 hp.	9.3	9.3	10.3	10.0	10.0	10.0
15 hp.	11.5	10.0	12.3	11.5	12.3	11.5
25 hp.	12.7	11.5	13.5	12.3	13.3	12.1
30 hp.	14.2	12.7	15.0	13.5	14.7	13.2
40 hp.	15.7	13.5	16.5	14.2	15.9	13.8
50 hp.	17.2	15.7	18.0	16.5	17.2	15.7
75 hp.	18.7	16.5	19.5	17.2	18.4	16.2
100 hp.	23.2	18.0	24.0	18.7	21.0	17.2

Notes: 1. For 25 cycle, increase units 10%.
2. For 2-phase, 4-wire, increase units 10%.



5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of Bulletin S-146.

TERRY

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1215

Be Kind to Salesmen

A salesman is not just a free lunch, his special knowledge can help you solve many problems.

Wingate H. Richardson, Consultant, New York, N. Y.

"Hey Joe, how about joining us for lunch today? We have a sucker in tow—good for a free meal."

I suppose every engineer has received such an invitation or heard such an invitation extended. You will readily recognize the "sucker" as a visiting salesman. But the casualness with which such invitations are accepted or declined often indicates a lack of appreciation of the real value of such a contact.

Salesmen like to talk seriously about their product and will if they know, or can find out, what particular information they have that will be interesting to you and applicable to your particular problems. If you want the conversation to be worthwhile, indicate your area of interest. If you want specific information, ask specific questions.

▶ **Catalogues Don't Tell All**—During a meeting of the Instrument Society, I listened to a discussion on the calibration of displacement meters. One of the speakers reported that some of the disaplacement meters calibrated by their instrument department operated satisfactorily only in the range of 5% to 60% of rated capacity.

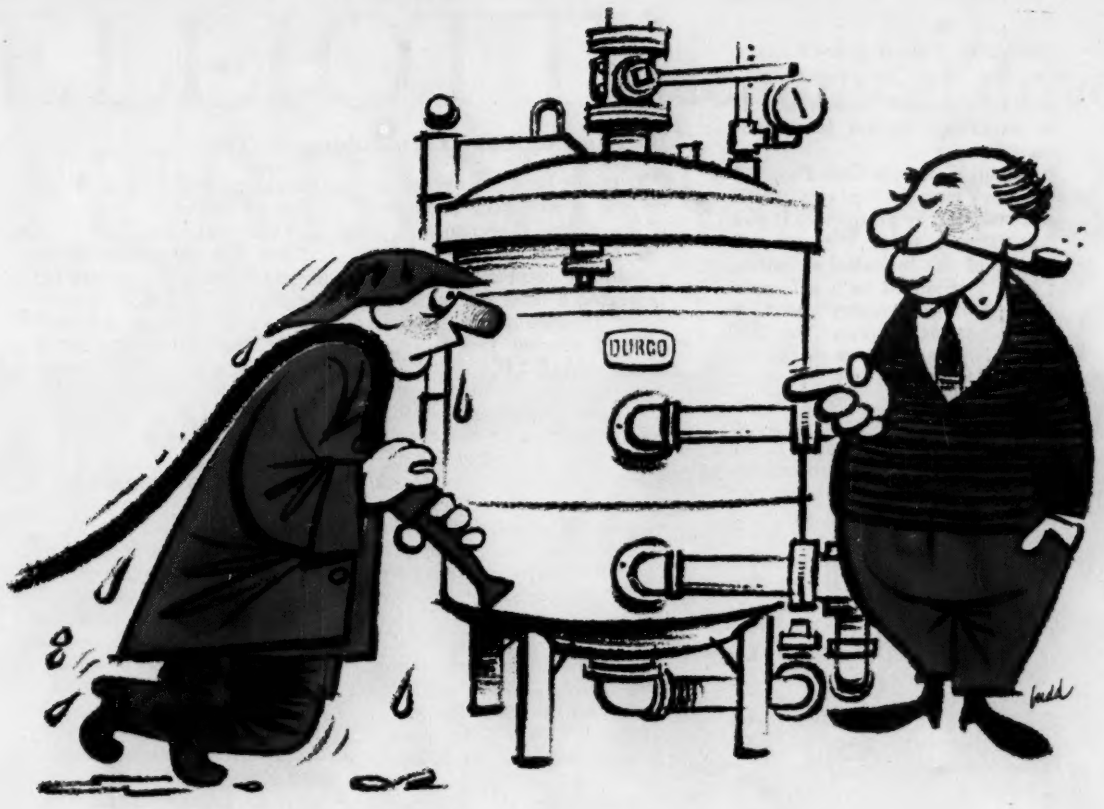
Displacement meters require very little attention from the operating department and so far as I knew we were having no difficulties with ours, but we did use a lot of them to meter raw materials to various production departments. I was interested in this lack of accuracy in the range above 60%. We always matched our pumps and meters to deliver liquid at 100% of the rated capacity of the meter. So, when the salesman next paid us a visit, I dug out my notes of the meeting and asked, "How about this?"

"Oh, I've got performance data on those meters. I'll get it out."

But when we examined his tables and charts, everything came to an end at 60% of rated capacity! Well of course that was a pretty good tip-off, but he said he would write to the factory for additional information. In less than a week he was back with a letter from his engineering department. The letter said, in part, "We normally do not provide this information in our literature or our catalogue since we feel that we are in an unfavorable competitive position in this respect. However, since your customer has asked a specific question about this, we feel that he should be provided with complete information. You may give him a copy of this letter and the attached data sheets."

I know that this kind of candid answer did not hurt them with us. We had been using their meters for a number of years with complete satisfaction and continued to do so.

As you can see, there are good reasons why equipment manufacturers do not "tell all." A characteristic that may put a vendor at a disadvantage in one instance may be unimportant in another. Yet if this item gets into a discussion the prospective buyer may say "Well, of course that is not important to us, but, who knows, maybe it will be sometime. We will think it over and let you know"—meaning that they will probably buy a competitor's product. Even so, it seems that many vendors are excessively reticent about supplying complete information on their



...HANG UP THE HOSE, HENRY!

This filter sluices with the lid on.

Durco-Enzinger engineers have developed automatic sluicing to handle any filter cake—even the thin, slimy ones.
Oscillating sluice—a solid jet stream moves back and forth across the face of each leaf.
Rotosluice—for horizontal tank filters. The sluice jet rotates through 360°, and a screw conveyer removes the cake from the tank.
Traveling sluice—designed for the most difficult cakes. High pressure sprays move down the face of each leaf.
Hydrojet sluice—permanently positioned spray nozzles in the cover sluice the entire surface of each leaf. Coupled with an air sparger this provides the simplest method of handling average sluicing jobs.

Contact your local Durco sales engineer or write for informative Bulletin EF/2a.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

ENZINGER DIVISION

THE DURIRON COMPANY, INC., Dayton, Ohio / Filters • Valves • Pumps • Process Equipment

product—another reason why it is important to ask intelligent questions.

▶ **Casual Contacts Can Pay Off**—Even casual contacts with salesmen can be productive if you want to talk shop. At a meeting of one of the technical societies, I was introduced to a salesman for one of the country's leading pump manufacturers. We had used his pumps on one of our recent installations and had a lot of trouble with packing gland leakage. We spent a lot of time on this problem but were never able to achieve what we considered to be satisfactory operation and resigned ourselves to living with the situation.

During my conversation with the salesman, I mentioned this problem—I suppose I was needling him a bit. He immediately started quizzing me about the steps we had taken to cure the trouble and finally got around to asking me if we were sure we had adjusted the impeller clearance properly.

Well, to make a long story short, we hadn't, because we did not know that such an adjustment was possible. It appears that though the manufacturer had a unique design feature regarding adjustment of the impeller clearance for the specific requirements of the installation, he had not thought to mention this in either his installation instructions or his operating and maintenance manual.

▶ **Cross-Pollination**—It is a curious fact that some techniques and the related equipment become very common and useful in one industry but for some reason appear to be completely unknown in another. Perhaps in this era of the specialist it is inevitable that one's field of interest should become narrow. You may not be inclined to spend much time listening to the merits of equipment which is not used in your field, but sometimes it pays.

Once, in setting up for a new process, we ran into a problem with motors for our pumps—we had d.c. power and needed explosion-proof motors. They were just not to be had. Even those suppliers who thought they could get them for us talked of impossible delivery dates. Then I remembered a conversation I had had some time before with a salesman, a casual visitor to our plant, during which we had talked about steam turbines. He had mentioned that these were available in small sizes.

We needed 1 hp. and I was not sure that turbines could be obtained in this size. But I called our pump vendor (the order for the pumps had already been placed) and asked him if he could equip these pumps with steam drive. He said he would see what he could do. He soon called back with the good news that we could get such drives in time for the scheduled delivery of the pumps.

I know that these pumps are used in steam plants, petroleum refining and marine installations, but, to the best of my knowledge, they are not common in the field of organic chemicals.

Since my boss was an old World War I Navy man, I got a lot of credit for this idea where it counted. On subsequent visits to the plant, the boss never failed to go down to the operating area to look at those little turbines.

▶ **A Free Consulting Service**—When major items of equipment are supplied, most manufacturers provide for a follow-up call which may include the services of an installation or service engineer—particularly if there is a performance guarantee—or merely a follow-up by the salesman. If this service is available to you, make the most of it—it can be valuable.

One of the last operations in a new process was evaporation and crystallization accomplished in four different types of evapora-

Be Kind to Your Own Salesmen, Too

It might be well to consider once in a while the problems of your own salesmen.

I had been assigned to a subsidiary company that had indicated a need for improvement in operations. Shortly after I started this work, I discovered that it was common practice for the members of the sales department to call in their orders to the department head producing the particular material. No single individual in the organization knew exactly what our production commitments were.

This situation was corrected by assigning responsibility for all incoming orders to a single individual. A simple system of plant production orders was set up so that I could tell instantly the status of any order. The system worked well and the sales department liked it.

Then one day Bill came down from the Research Lab carrying a folder. Bill opened the conversation:

"Since you are now keeping track of all orders, I thought I might as well turn over my order file to you."

"Your order file?"

"Yes. The sales department always called us for orders for samples."

"Let's see what you have."

The first order was for a gallon of a specially blended material. It was several minutes before I noticed the date on the order—it was six months old.

"Is this the right date?"

"Oh yes."

"What's holding it up?"

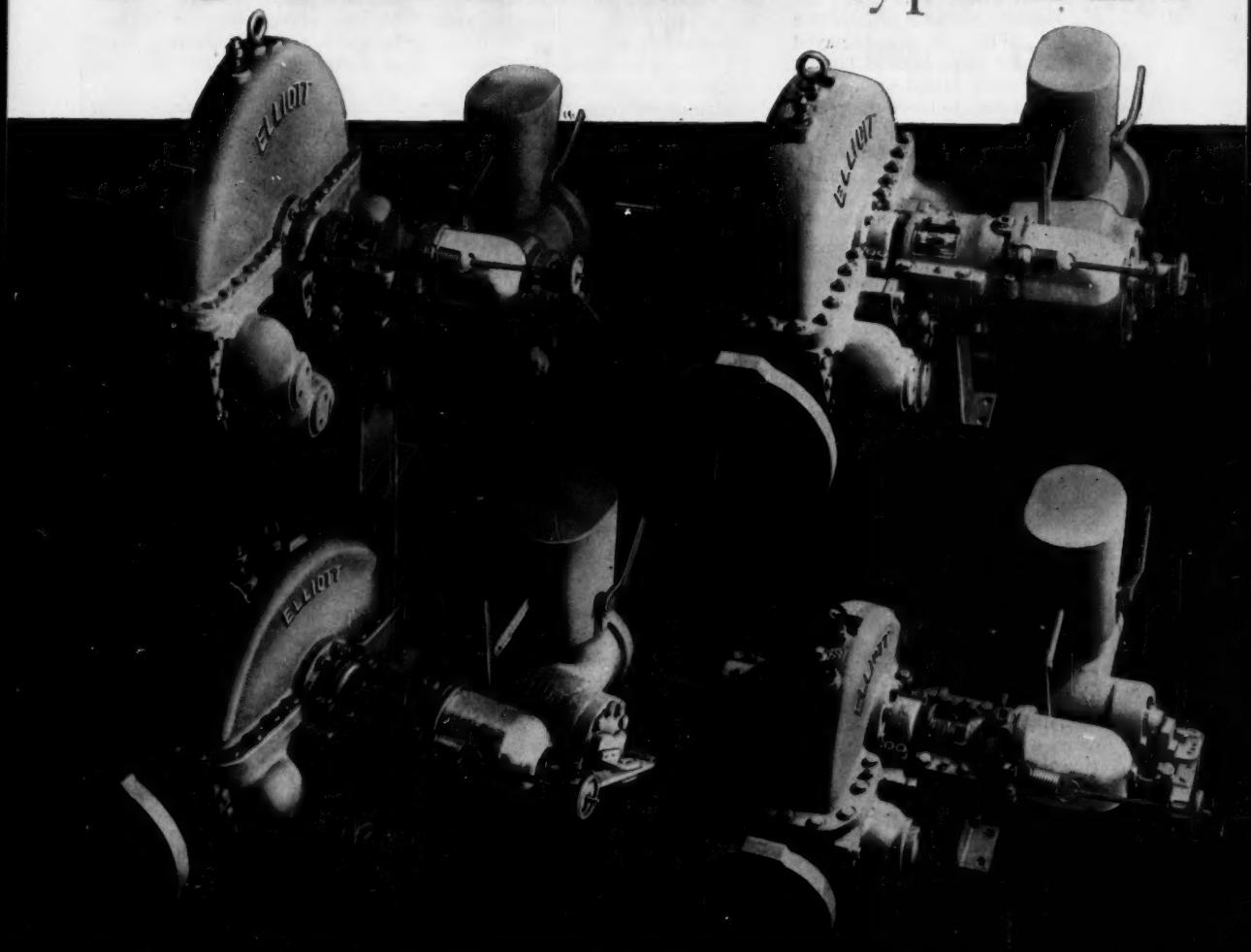
"Well it is a difficult blend to make. I thought I would wait until an order came in for the material and then get a sample from the production department."

"And how do you suppose the salesman is going to get an order for the material if he can't get a sample for the customer's examination?"

"Gee, I never thought of that."

Admittedly, this is an extreme example of the lack of cooperation salesmen sometimes get.

ELLIOTT mechanical drive TURBINES type YR



STURDY! WEATHERPROOF! DEPENDABLE!

All-weather protection, standard for Elliott type YR turbines, assures dependable operation under all conditions of heat, cold, moisture, dust and contaminated atmosphere.

The direct-acting speed-governing system is simple and positive, available in several modifications to match speed and pressure requirements. The rugged rotor assembly is dynamically balanced. Bearings and shaft seals are readily accessible for maintenance. Hand valve reduces steam consumption at partial loads.

Many other features contribute to the dependable and economical performance of Elliott type YR turbines. Write for complete details to Turbine Division, Elliott Company, Jeannette, Penna.

ELLIOTT Company
Jeannette, Pennsylvania

HO-9

tors supplied by four different companies.

I was told that one of the companies wanted their sales representative present when their unit went on stream and I had been expecting him for the start-up which was scheduled for Friday. Well, he was delayed and did not appear until late in the day after I had cleaned up and was ready to leave the plant.

Joe was not an operating engineer, he was a salesman, an equipment peddler, but he knew his evaporators and he talked while I listened. He spent the better part of the time from six o'clock to midnight with me while that evaporator went on stream and I probably learned more in about four hours than I would have learned in the next four months.

I learned about the practice of the art, the intangible factors that go into the making of good crystals, the look of the bed as it rolls up out of the calandria, the causes of excessive splashing, possible indications of air leakage, indications that the calandria was starting to plug up and what to do in each case. All of this came from Joe's years of experience for obviously all of these things did not happen in the four hours that he was there.

Whether this evaporator was actually the best of the four because of its design and construction, or whether it gave the best performance because of his indoctrination, I do not know, but it is a fact that it did out-perform the others.

▶**For Freer Information Exchange**—One of the characteristics of the chemical business is secretiveness about processes and operating methods. This is usually ascribed to the highly competitive nature of the business, but I am sure there are many other industries just as competitive. On one occasion, when I was swapping experiences with an engineer in the petroleum field, I obtained a considerable amount of technical information. I expressed my appreciation and indicated that his willingness to impart information about his operations was unusual and certainly in marked contrast to the policy in the chemical field.

I have always remembered his reply, "We can be as secretive as anyone about our work in research and development. But when we have the final results, we are quite willing to make the information available. Sometimes it is protected by patents and sometimes not, but we feel that the free exchange of technical information is essential to the health of the industry and we all benefit. Our business is as competitive as anyone's, but we compete in the field of operating skill."

▶**But Respect Your Company's Confidences**—Whatever the reasons, if your management feels that their know-how is to be kept secret, then you must be careful to do so when talking to salesmen. But, sometimes your best attempts to avoid disclosure of confidential information are unsuccessful.

Once we were designing a plant for the Army. During the early stages of the project there was much confusion about meeting the requirements of the Army and we were all acutely conscious that the project was classified "Secret." So we were all trying to be very careful.

One day, Ivan, an equipment salesman, came in to discuss a proposal for a large compressor. He sat across the desk face to face with Charlie, who was briefing him on our requirements. Charlie explained that we needed a compressor of such and such capacity but because this project was secret, he could not tell him what the gas was. He would accept a proposal based on a compressor for air.

While all this conversation about secrecy was going on, the salesman was casually scanning the wall behind Charlie where all the process sheets were hung for ready reference.

▶**Help Turn Waste to Profit**—Your salesmen can sometimes be a real help with your production problems.

Raw material for an extraction operation was an agricultural product the bulk of which remained as waste to be disposed of. Considering some of the problems in waste disposal, this stuff was no problem at all—we hauled it to the local dump. But it was annoying to pay trucking charges for something we were throwing away.

It occurred to me that since this material came from an agricultural source, it might be possible to return it to that source as stock feed or as a constituent of commercial fertilizer. It contained some residues that could conceivably be valuable in either of these cases.

I called the sales department and explained the problem; they went to work on it. Soon thereafter, we were shipping this material to a customer instead of hauling it to the dump.

▶**How to Shock a Salesman**—One of our subsidiaries held firmly to the idea that any visitor to their plant was a guest to be treated with all the courtesy normally accorded a guest. Occasionally, uninvited salesmen would be in our offices at lunchtime and would invite us out.

"Sure, I'll get some of the boys and we'll all go up to town."

Our plant was in an area where satisfactory dining rooms were scarce and a number of us usually dined together. I am sure my reply to the invitation frequently caused some consternation since our visitors must have had limited expense accounts, if any, and they knew their chances of doing business with us were almost nil.

Well, when it came time to pay the check, the salesman was told that the check had already been paid. They generally survived the shock.

So if you have a salesman who has been giving you good service and attention, try picking up the tab yourself once in a while. He may have to knock off for the rest of the day, but you will be surprised at what a pleasant experience it can be for you.

After all, it is more blessed to give than to receive.

Previous Articles In This Series

Sept. 21—Temperature Control

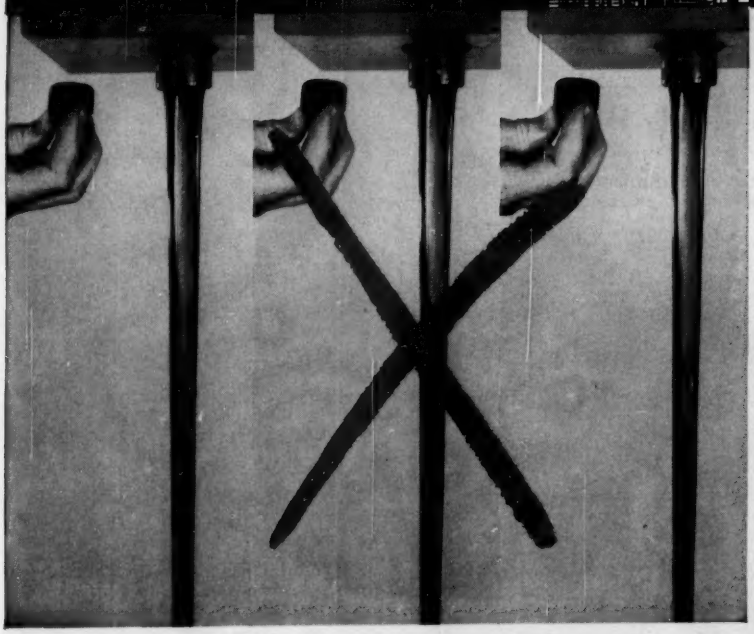
Nov.30—Inventory Cheating

Feb. 8—Specifications

LUBE LOGIC

3 WAYS TO IMPROVE EQUIPMENT PERFORMANCE

TEXACO



How to cut drain periods yet improve hydraulic performance!

Drain periods for a hydraulic system may be extended many times over by switching from straight mineral oils to a premium oil.

This has been proved time and again when the switch has been made to Texaco Regal Oil R&O without altering any other operating conditions.

It's obvious that draining hydraulic systems, cleaning, and replacing with new oil is costly. If one or more drainings can be eliminated the additional oil cost would be warranted.

Straight mineral oil may be satisfactory for some systems, but tests show that Regal Oil R&O can extend the interval between draining at considerable savings. This premium oil is formulated to resist oxidation, rust, foam, and wear.

And there's a bonus! When you do drain, you'll find the system in cleaner condition. You'll save again on make-ready.

Watch out for bumps and grinds in gear boxes!

When the enclosed gears in your plant start making noises like an overloaded washing machine, it's likely to cost your company some money. That's because you're probably listening to severe wear on gear teeth.

Make a quick check of the alignment and the clearance between the gear teeth. Then, check the bath level of the oil. If it's too low, the gears will just "slap" into it. What you want is a paddlewheel action that will keep the gears covered with the lubricant.

If there's still noise after your check, it will pay you to call in a TLE*.

One way to prevent bearing failures

Preventing bearing failures before they develop is often just as easy as getting reports from Production Management. In fact, that's how you do it. When you find that Production has made a change in operating conditions, or an adjustment in process equipment, that's your signal for action.

First step is to determine whether or not the bearings can take the new operating situation. You'll want to check for changes in temperatures and loads, for increased moisture and dust, and for extra exposure to corrosive materials.

Second step, equally important, is to make sure the grade of lubricant you've been using still fits the new conditions. Your TLE* can show you how to determine this.

*Your TLE and Organized Lubrication

Your Texaco Lubrication Engineer can offer you many helpful hints on the lubrication and maintenance of process equipment. He'll also be glad to help you plan toward Organized Lubrication as a means of raising production, controlling maintenance costs and downtime, and extending equipment life. Texaco Inc., 135 East 42nd Street, New York 17, N. Y.

TUNE IN: TEXACO HUNTLEY-BRINKLEY REPORT, MON. THROUGH FRI.-NBC-TV

PRACTICE . . .

CORROSION FORUM

EDITED BY R. B. NORDEN

CORROSION-CONTROL DESIGN 3a

Part of a series appearing throughout 1960
First of two articles on reactor design

Often Overlooked Reactor Design Factors

- Exceed ASME code requirements (for corrosive situations).
- Avoid severe metal forming.
- Specify welding rod composition.
- Clearly indicate back-chipping and weld-finish requirements.
- Inspect all welds carefully.
- Consider heat treatment of fabricated assembly.

John E. Dawson, Hercules Powder Co., Inc., Wilmington, Del.

Pressure reactors: probably in no other piece of equipment is design as important for controlling corrosion.

Of course, major design items such as wall thickness, type of alloy, number of nozzles, are well discussed and understood between designer and fabricator. But very often minor design factors are overlooked—in many cases these create the major corrosion problems.

This, and the following article, is addressed to the young process or design chemical engineer with little experience in vessel procurement. We will discuss, in this first part, items which should be clearly understood by buyer and fabricator or by chemical and mechanical engineers involved in the design in the buyer company (*see above*).

Good design, by definition, should yield an operating vessel which will give a maximum safe life with a minimum of downtime for maintenance. When purchasing a vessel, paper design (including drawing and specifications), fabrication quality conforming with design, and inspection required to assure both the fabricator and purchaser that the design has been met, are vital.

► **Process Information**—Generally, the process engineer must make certain information available to the mechanical engineer for the basis of vessel design. This information need not always be complete and many items must be left flexible to meet design conditions.

Here is a typical list:

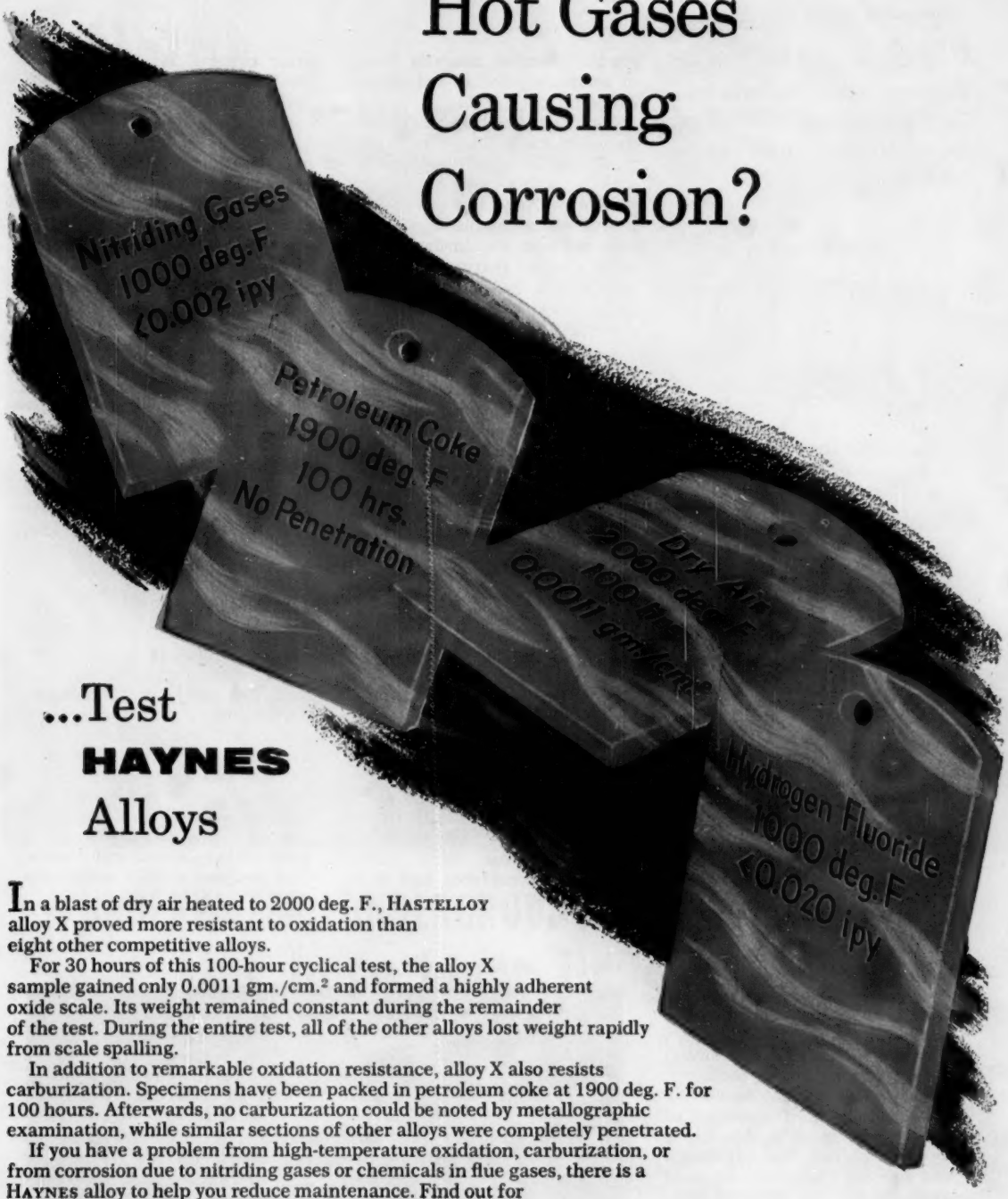
- Required capacity and free board allowance, usually expressed in gallons.
- Desired diameter along with length-diameter ratio (L/D) required to meet processing conditions.
- Intended use of the vessel, such as reactor or hold or mixing and drying.
- A brief description (not necessarily its chemical name) of the process material in the vessel, including density.
- Agitation requirements.
- Heating and/or cooling requirements and the general method of heating or cooling such as coils or jackets.
- Pressure-temperature cycling data.
- Knowledge of corrosive conditions expected and effects

1. Plant Site, Layout Minimize Corrosion, Jan. 11, 1960, p. 144.
2. Proper Design Voids Equipment Corrosion, Feb. 22, 1960, p. 162.

. . . Future Articles

Valve design for severe corrosive service.
Design of heat exchangers to minimize corrosion.
Storage tank design.
Design of mixers to minimize corrosion.

Hot Gases Causing Corrosion?



...Test HAYNES Alloys

In a blast of dry air heated to 2000 deg. F., HASTELLOY alloy X proved more resistant to oxidation than eight other competitive alloys.

For 30 hours of this 100-hour cyclical test, the alloy X sample gained only 0.0011 gm./cm.^{2} and formed a highly adherent oxide scale. Its weight remained constant during the remainder of the test. During the entire test, all of the other alloys lost weight rapidly from scale spalling.

In addition to remarkable oxidation resistance, alloy X also resists carburization. Specimens have been packed in petroleum coke at 1900 deg. F. for 100 hours. Afterwards, no carburization could be noted by metallographic examination, while similar sections of other alloys were completely penetrated.

If you have a problem from high-temperature oxidation, carburization, or from corrosion due to nitriding gases or chemicals in flue gases, there is a HAYNES alloy to help you reduce maintenance. Find out for yourself by testing them.

We'll gladly send you samples. But to make sure we send you the alloy or alloys most nearly suited to your need, we ask that you send a letter outlining your own particular conditions. If you would like to learn more about alloy X, ask for a copy of the booklet, "HASTELLOY Alloy X."

HAYNES ALLOYS

HAYNES STELLITE COMPANY

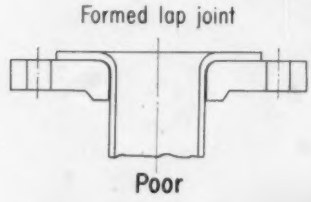
Division of Union Carbide Corporation

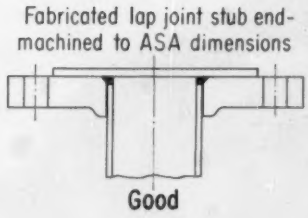
Kokomo, Indiana

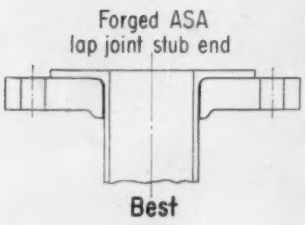
UNION CARBIDE

The terms "Haynes," "Hastelloy," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

. . . severe cold bending or forming must be avoided; particularly, don't form Van Stones (formed lap joints) on pipe nozzles . . .







on the selected metal in the as-fabricated condition.

- Anticipated years of service.
- General type of closures and gasket material requirements.
- Other pertinent information such as entry problems, feeds, and instrumentation.

Proper choice of materials of construction must be determined by the combined efforts of design and process engineers. In most applications, the process engineer has background experience or has available information on the proper group choice of materials. If no background is available, it will be necessary to simulate the conditions and be guided by these results.

All materials used in vessel fabrication must be identified by mill test reports, stamping or stenciling on individual pieces, simple chemical analysis tests, or complete physical and chemical tests.

No attempt will be made here to select materials. The literature contains many useful articles on this subject.

▶ **Code or Non-Code**—Based on pressure-size conditions, the design engineer should first determine whether there's a need for ASME code construction to conform to insurance, municipal, or state requirements.

If code construction is required, keep in mind that the ASME code is a minimum safe design specification: in most cases for corrosive service, mechanical design should exceed these minimum requirements.

If non-code construction is called for, care must be exercised in preparing complete specifications and design to assure quality and to help the fabricator make a fair bid. In most cases, non-code design requires more paper detail and the buyer's inspection must be more complete.

▶ **Avoid Severe Forming**—It's a known fact that residual stresses remain in metals after cold working. Under certain conditions, these stresses can produce a condition causing rapid corrosion. Good reactor design, therefore, involves elimination of severe metal forming. The diameter-thickness ratio (D/t) should be considered and if no prior criteria exist, apply the limitations given in ASME Code Section VIII.

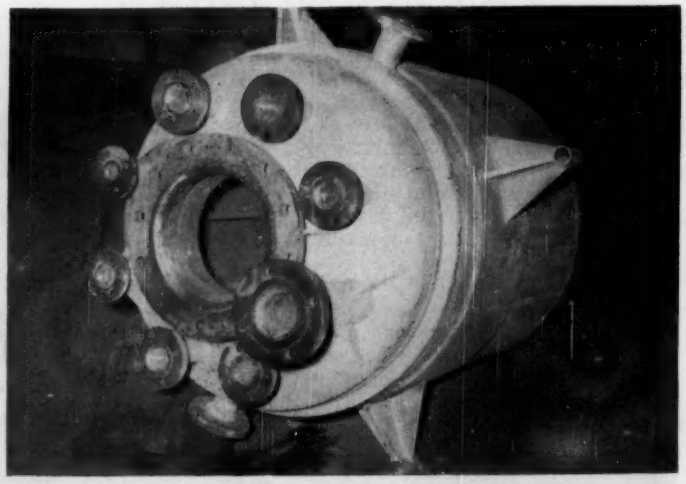
Good design also calls for removal of residual stress by thermal treatment, where this is needed. Formed parts such as heads and expansion-joint sections should always be specified annealed after forming to reduce residual stresses.

Other severe cold bending or forming must be avoided, such as the common practice of forming Van Stones on pipe nozzles (*see drawings*).

In some situations, it is well to inspect formed parts by oil penetration or radiography to detect any faults.

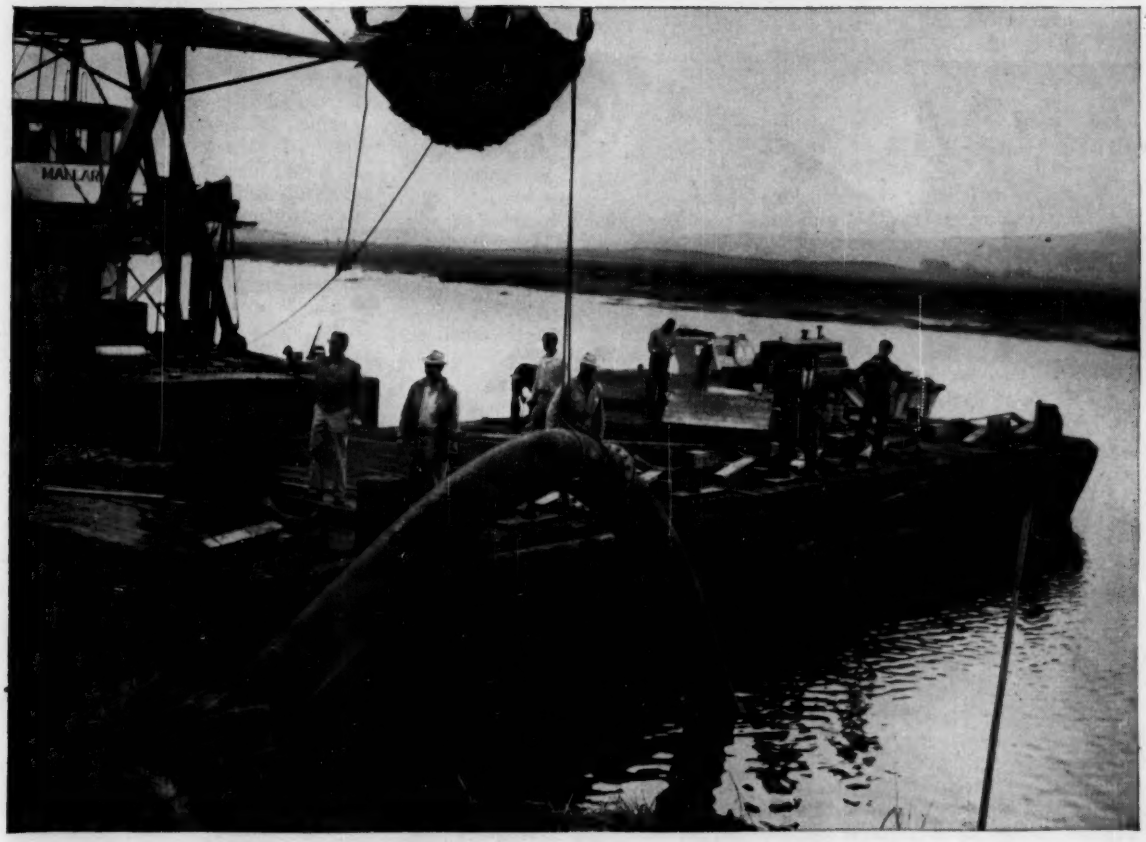
▶ **Most Important**—In most process-vessel design, welding is the most important single item of fabrication, requiring close surveillance in design, specification, fabrication, and inspection.

There are a great many methods and procedures for obtaining quality welds. No attempt will be made to describe or recommend any of these. Normally it is best to let the choice of method and procedure of welding remain with the fabricator. However, the design engineer should clearly understand and review the information before fabrication to assure that it is compatible with the materials and will produce the desired end results. The designer should specify the



COMPLEX REACTOR handles severe corrosives with little maintenance.

US RUBBER PILOT PIPE



UNDERWATER, UNDERGROUND— this hose loves its salt diet

A large western salt company,* expanding its operations, faced an unusual problem recently: How to economically and efficiently move brine solution across the 600-ft. wide Napa River.

So they turned to 16" U.S. Rubber Pilot® Pipe.

Metal pipe could not be used because it would corrode quickly and because it lacked flexibility. But corrosion-resistant, flexible rubber Pilot Pipe has no trouble withstanding the salt water that has acid content with a PH ranging from 2.8 to 3.5. Moreover, it is flexible enough to follow the contour of the river bottom on which it lies and to handle any shifting due to river currents. Its sturdy cover is unaffected by both river silt and exposure to weathering (where it comes out of the water on either side of the river).

You'll find U.S. Pilot Pipe at work in a wide range of industries, in a wide variety of demanding uses. It's available to you at your "U.S." Distributor.

*Leslie Salt Co., Newark, Calif.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division
US RUBBER United States Rubber
WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS
Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

. . . lined vessels for very severe corrosion service, if economically justified, involve more precautions in design and inspection to assure sound fabrication . . .

chemical composition of the weld rod by reference to ASTM standards, particularly in corrosive service. This normally eliminates the chance of incorrect choice by the fabricator. Welding from one side only should never be permitted at any location.

On ASME code vessels, back chipping is necessary to obtain quality strength welds. However, as mentioned earlier, on non-code vessels, more detailed design is required. It is always advisable to clearly specify back chipping requirements. This is an important cost item to the supplier in competitive quoting.

▶ **Weld Finish**—Weld finish should be clearly specified. Due to lack of a standard weld finish measurement, care should be taken to assure that both the purchaser and supplier are in agreement.

The finish should include such items as the inside of seams, outside of seams, nozzles, internal and external attachments. Corrosion can be accelerated by weld projection and roughness. All weld splatter should be removed.

Welding of dissimilar metals is sometimes required to meet design conditions or cost considerations. This is particularly true of external parts welded to vessels, including temporary clips welded in the shop to facilitate handling or fitting. Various welding standards exist on requirements to prevent contamination of the internal surface by migration and burn-through. This item should be made clear.

Overlays are frequently used to reduce the weight of relatively expensive materials. It is important to specify the number of weld passes required and the finished thickness.

▶ **Inspect Carefully**—Completed weld inspection is of fundamental importance to produce quality mechanical strength and corrosion resistance. Degree of inspection will vary to meet quality and economic requirements.

Visual inspection, particularly on thin sections, with the aid of magnification lenses can be satisfactory for some vessels. For more detailed inspection of surface faults use oil penetration—low-cost and very effective. This method should be considered as minimum for corrosive service.

Specify radiographic examination of welds where sub-surface flaws must be disclosed to meet corrosion or strength requirements. This is an expensive method and is not normally used to detect surface flaws. However, where strength is of primary importance, as it is in most pressure vessels, radiography has proved to be economically justifiable. But a supplementary detailed surface inspection should be made for corrosive service.

There are other methods of nondestructive testing available, such as ultrasonic and magnaflux, which serve a specific inspection service and certainly should not be overlooked.

Where repairs are needed, it is important to assure yourself that the proper method is used. And without proper inspection, repairs can be more detrimental than the original flaw.

Where overlays or plug welds are used, the finished surface should always be checked by a suitable method to assure against cracks and crevices.

▶ **To Clad or Not . . .**—In most cases for clad or lined vessels (or parts of vessels), the purchaser will give more paper detail and specifications. This is because of the complex nature of clad fabrication, involving welding procedures, number of passes on the clad side, weld alloy, weld finish, inspection of fits, solid alloy vs. lined nozzles, weep holes for testing internal welds, and final inspection.

In general, lined vessels for very severe corrosive service, if economically justified, involve more precautions in design and inspection to assure sound fabrication.

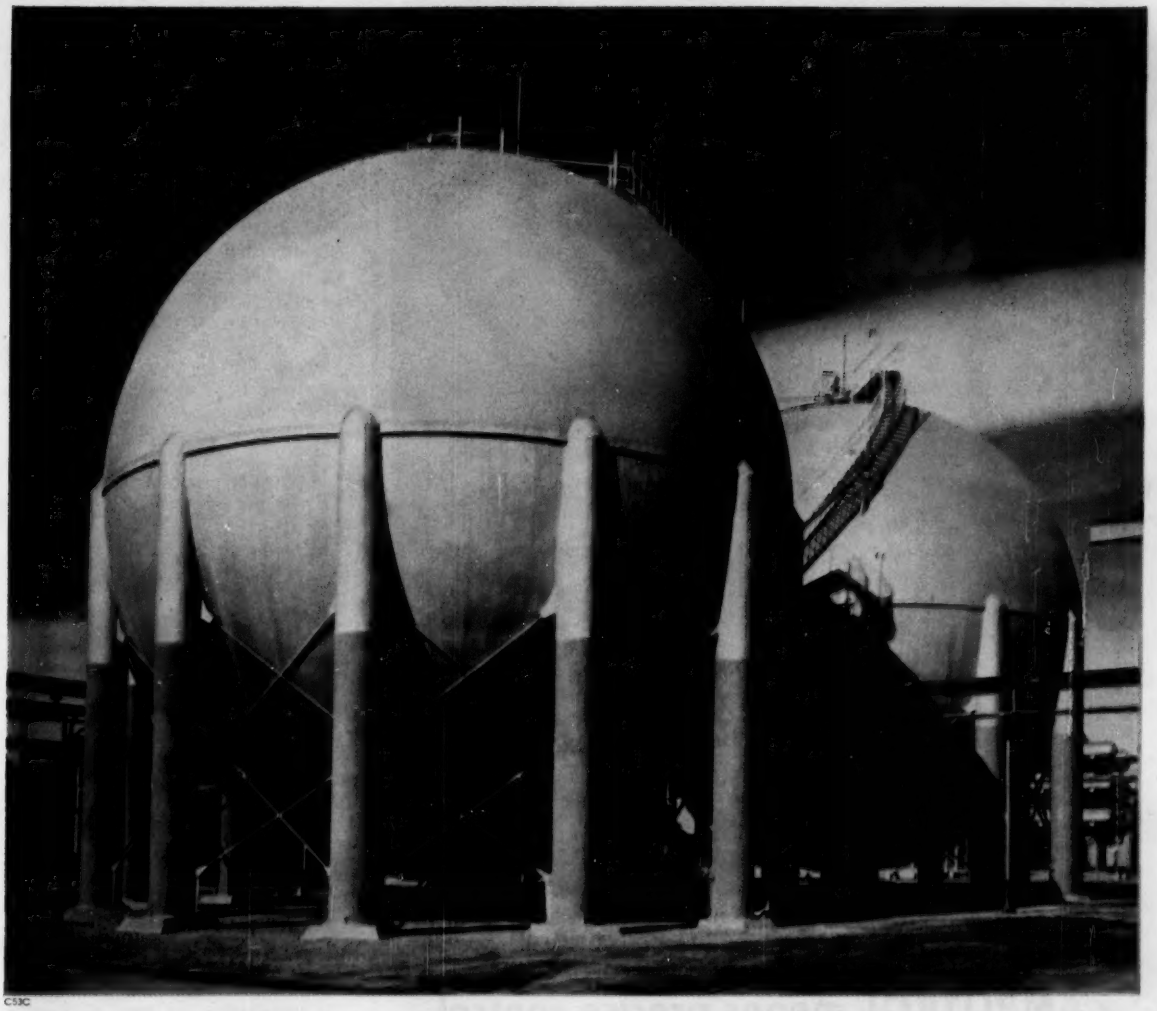
This subject has been only briefly mentioned because the special design features would require considerations outside the scope of our article.

▶ **Heat Effect**—Heating to high temperatures and cooling at an uncontrolled rate, which is what normal welding does, can cause internal structural changes in a metal as well as residual stresses. Both can be detrimental to corrosion resistance.

The need for proper thermal treatment of a fabricated assembly must be evaluated. Perhaps only a portion (sub-assembly) need be treated or perhaps the entire completed assembly. It is well to specify or discuss any proposed thermal treatment with the supplier to assure complete understanding. Vessel fabrication must follow certain procedures and if thermal treatment is required, it should be included during fabrication. Surface of the material of construction must be clean to eliminate local reactions caused by grease or oil spots, paint marks, and shop dirt.

▶ **Look for Second Article**—The second article on reactor design will appear in the next issue and will discuss design of coils, jackets, other internals, nozzles and manways to reduce metal corrosion.

JOHN E. DAWSON has been with Hercules Powder for 18 yr. He is a senior engineer in a specialist group of the engineering dept. Mr. Dawson is primarily responsible for design of chemical process equipment ranging in pressures from zero to 1,000 atm. and from subzero temperatures to 1,800 F. He is a graduate (B.S. in mechanical engineering) from the University of Delaware, a member of ASME, and a registered P.E. in Delaware.



C53C

Twin Hortonspheres Store Anhydrous Ammonia

United States Steel Corporation's nitrogen products plant near Provo, Utah, produces chemical fertilizers and industrial acid.

Built at the site of U. S. Steel's Geneva Works, the chemical facility utilizes coke oven gas recovered from steelmaking process to produce anhydrous ammonia. In its liquid form, the product is stored at approximately four times atmospheric pressure in the twin Hortonspheres shown above. Designed, fabricated and erected by CB&I, each structure is 60 ft. in diameter and has a 2,100-ton capacity.

Wherever chemical products are processed or stored, you'll find CB&I *Craftsmanship in Steel*. For details write our nearest office.

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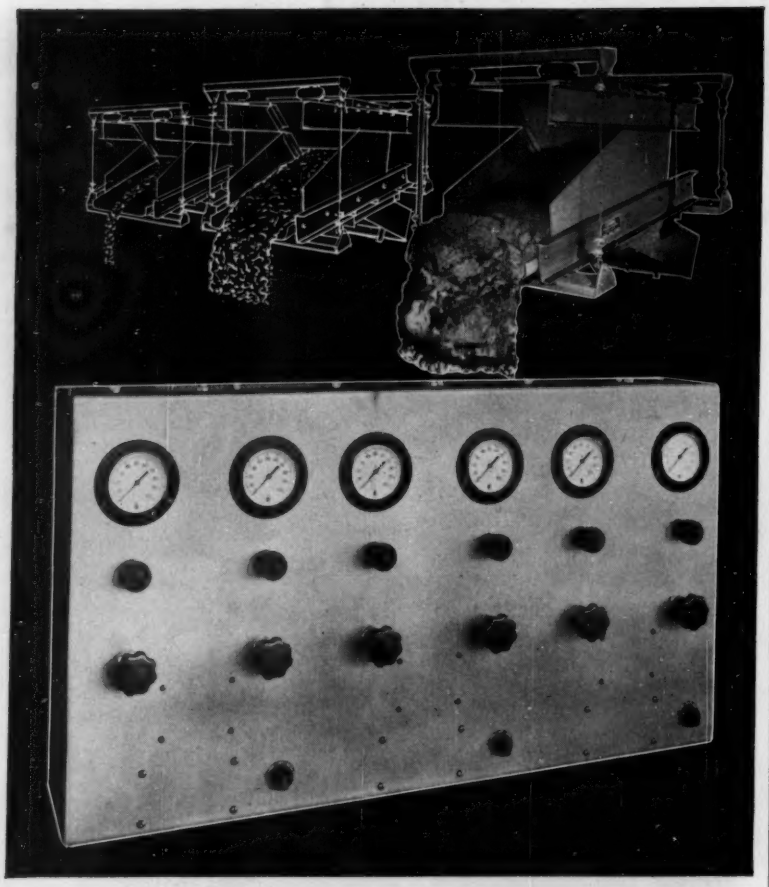

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With Carrier Amplitrol Feeders you can control discharge rates from ANY distance. Carrier Feeders give you precise manual OR automatic control in response to signals from bin-level indicators, process-alarms, scales, load cells, ball mill or crusher drives.

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DEWATER • SCREEN
COOL • DRY
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DISTRIBUTE • ELEVATE

(*Continued from p. 68*)

active waste storage can handle up to 400 gal./min. of liquids.

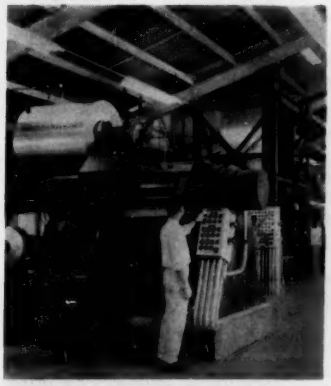
Camp Bird Colorado, Inc. just started construction of its new, 500-ton/day lead-zinc concentrating mill near Ouray, Colo. New concentrator, to unscramble complex Camp Bird ores, is scheduled to go on stream this fall; Western Knapp Engineering Co., San Francisco, Calif., is designer-constructor of the new plant.

Eastman Kodak Co. announces completion of this polyester film plant at Rochester, N. Y. New facility features high-temperature process equipment for polyester synthesis and continuous film formation equipment; new polyester film is unusually strong and offers high dimensional stability for true color rendering in printing processes.

Pennsalt Chemical Corp., Philadelphia, Pa., is laying the groundwork to produce alkyl alkanol amines at its Wyandotte, Mich., plant. New facility, to cost $1.5-million, should go on stream by the end of the year to produce the new amines for anesthetics, textile lubricants and ion-exchange resin manufacture.

Du Pont discloses details of expansion and modernization of its Spruance Works near Richmond, Va., where Teflon

fiber is produced. Increased application of Teflon for packings, seals, filter cloth, diaphragms, gaskets and bearing spurred the expansion program.



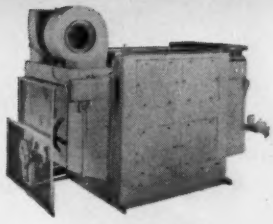
Kaiser Aluminum & Chemical Corp. has just put into operation this automatic aluminum-coil painting line at its modern Ravenswood, W. Va., plant. New 66-in. paint line roll-coats aluminum coil continuously.

Columbia Southern Chemical Corp. has begun construction of a $1-million ethylene dichloride plant at Lake Charles, La. New unit will be adjacent to the firm's chlorine-caustic plant, which will supply feed material. Ethylene dichloride output is expected to go to vinyl chloride production.

Allied Chemical Corp. announces plans for expansion of its Nitrogen Division's South Point, Ohio, plant. Methanol capacity will be increased 50% and formaldehyde capacity by 35%. Formaldehyde increase will up Allied's potential for urea-formaldehyde resin production.

Seiberling Rubber Co. reveals plans for major improvement and expansion of its Barberton, Ohio, tire plant. Seiberling subsidiary, Copolymer Rubber & Chemical Corp., concurrently announces an $8-million modernization and expansion program to in-

Tableting machines don't clog when workrooms are desert-dry

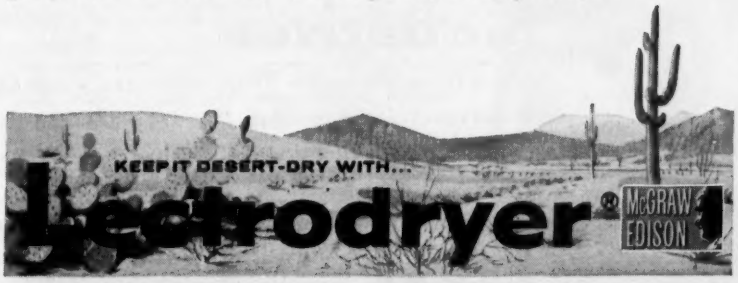


New Type CH Lectrodryer

A CHO Lectrodryer maintains the 15,680 cubic foot area of this tableting room at 20% relative humidity, regardless of conditions out-of-doors. So, when humid weather ordinarily causes hygroscopic powders to gum up and stop flowing, production is maintained here at full speed.

Have you, in the past, considered controlled dryness and found it too costly? It may pay to reopen those files and ask Pittsburgh Lectrodryer for drying recommendations. Dehumidification methods and efficiencies of dryers have been developed so much recently that the cost picture may be completely changed.

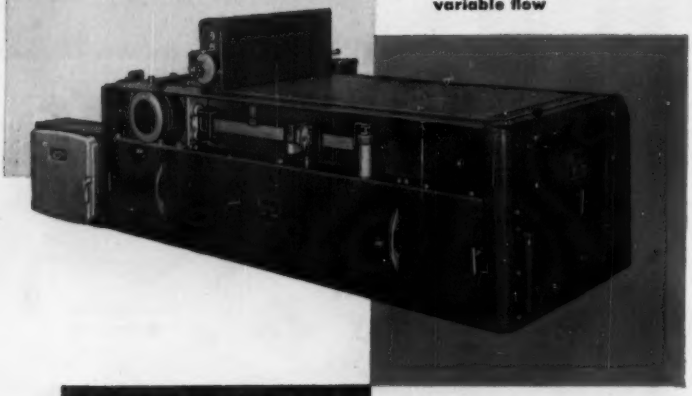
DATA SHEETS ARE AVAILABLE which describe typical humidity control installations. They'll serve as guides in planning your own systems. For copies and for other drying help, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 303 32nd Street, Pittsburgh 30, Pennsylvania.



POSITIVE CONTROL OF MATERIALS IN MOTION BIF METERS FEEDERS CONTROLS

B-I-F BELT WEIGHER SOLVES PROCESS MEASUREMENT AND CONTROL PROBLEMS

- Checking production line output
- Checking in-plant inventory
- Weighing incoming and outgoing bulk shipments
- Evaluating process efficiency
- Density checking
- Batch weighing
- Signal producing for pacing additive materials proportional to a variable flow



CASE STUDY No. 1

BIF Omega **Pneu-Weigh Belt Weigher** checked production line output of 50 volumetric feeders to maintain critical limits . . . reduced plant downtime, lost man hours and production holdups!

Each feeder on proportioning line of a major formulator was putting out particular fraction of formula on continuous basis. Pneu-Weigh, installed at end of collector conveyor to "watchdog" operation through remotely located instrument, indicated less-than-expected output. A check revealed delivery rate of one volumetric feeder crtically lower than its limit. Result: over 100 tons of formulated product saved from being remade at considerable expense in plant time, man-hours, planning, removal of paper-bag packages, and subsequent resacking.

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crease rubber raw-material output.

Enpaques de Carton Titan, S. A., Monterrey, Mexico, reports successful startup of its new 60-metric-ton/day continuous pulp mill, which produces unbleached pulp from wheat straw. New plant embodies a Pandia continuous digester, with 42-in. digester tubes and a Pandia discharger, Black-Clawson supplied the digester, while Parsons & Whittemore supplied other process equipment.

Niagara Brand Chemicals, Hamilton, Ont., is now equipped to supply the Canadian rubber industry with sulfur; Niagara has completed construction of a sulfur mill at its Burlington plant, to produce suitable sulfur powders for rubber blending.

Eastman Kodak Co., Rochester, N. Y., will soon complete this giant water-treatment facility, which is capable of producing up to 36-million gal./day of pure feed water for film chemicals manufacture. Shown above is the 60-ft.-dia. tank, which will be used to treat 270,000 gal./hr. of Great Lakes water.

Wyandotte Chemicals Corp. discloses tentative plans for construction of a polyether plant at Washington, N. J. If current negotiations are successful, Wyandotte will supply Pluronic, Tetronic and Pluracol from the new location.

Continental Carbon Co. moves westward with plans for construction of a $2.5-million carbon-black plant at Bakersfield, Calif. New facility, to

produce 15,000 tons/yr. of carbon black for rubber blending, will be the first such plant on the West Coast.

Collier Carbon and Chemical Corp. has awarded Leonard Construction Co., Chicago, Ill., the engineering and design contract for a contact-sulfuric acid plant, to be built in the Los Angeles, Calif., area. Plant, with its rated capacity of 250 tons/day, will use spent alkylation acid, hydrogen sulfide and elemental sulfur as feed materials. Rigid air pollution regulations in the Los Angeles area, make necessary special mist eliminator and fume emission features in the plant design.

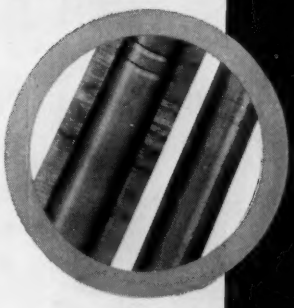
Dow Corning Corp., Midland, Mich., is reaching for foreign markets with the formation of two overseas subsidiaries: Dow Corning, A. G., Basel, Switzerland, and Dow Corning International, S. A. of Panama.

Jefferson Lake Sulphur Co. joins forces with Trans-continental Gas Pipe Line Corp. to form Trans-Jeff Chemical Corp., with offices in Houston, Tex. New firm will build and operate a plant near Tilden, Tex., for recovery of sulfur from waste acid and gas streams.

Princeton Chemical Research, Inc. has been formed at Princeton, N. J., to offer contract research and development services. PCR specializes in petrochemicals, polyolefins and catalysis.

Bzura Chemical Co., Keyport, N. J., has just formed Productos de Fermentacion with prospects of constructing a citric-acid plant in Mexico. New plant will employ the deep fermentation process,

NEW ELLIOTT TUBE EXPANDERS roll tubes into thick sheets in one pass



Use of **NEW** continuous-rolling technique here—shows uniform seal, with all Keys preserved, and no signs of shear

OLD step-rolling method results in non-uniform surface . . . distortion of Keys where rolls have overlapped

Better seal . . . Smoother surface . . . Much Faster operation

This new concept in tube expanders was developed by Elliott to roll the thickest tube sheets. Using a continuous-rolling method, it eliminates many problems common to step-rolling, may be operated protractively or retractively, saves time, assures uniform, smooth surfaces, avoids annular voids or erratic tube inside diameters, provides better seal.

Accessories

Elliott also makes a complete line of retubing accessories, including both electric and air magnetic Tube Rolling Controls, Tube Gages, Tube Plugs, Tube Cutters, etc.—in addition to a complete line of tube expanders. *Ask for Bulletin Y-52.*

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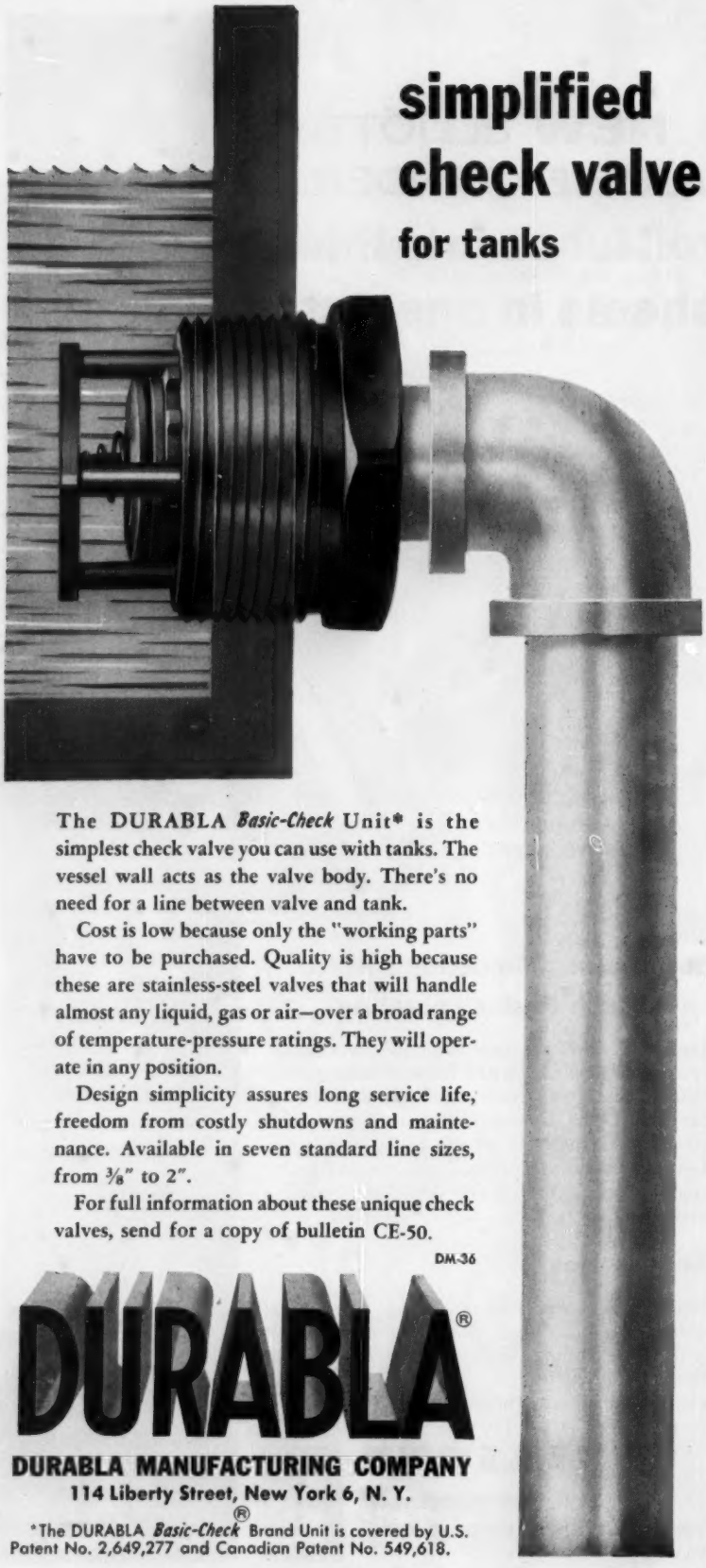

simplified check valve for tanks

The DURABLA *Basic-Check* Unit* is the simplest check valve you can use with tanks. The vessel wall acts as the valve body. There's no need for a line between valve and tank.

Cost is low because only the "working parts" have to be purchased. Quality is high because these are stainless-steel valves that will handle almost any liquid, gas or air—over a broad range of temperature-pressure ratings. They will operate in any position.

Design simplicity assures long service life, freedom from costly shutdowns and maintenance. Available in seven standard line sizes, from ⅜" to 2".

For full information about these unique check valves, send for a copy of bulletin CE-50.

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*The DURABLA *Basic-Check*® Brand Unit is covered by U.S. Patent No. 2,649,277 and Canadian Patent No. 549,618.

which Bzura proved successful at its Fieldsboro, N. J., plant.

Trancoa Chemical Corp. announces the formation of a new Plastics Division, to produce polyurethane resins for coatings and adhesives.

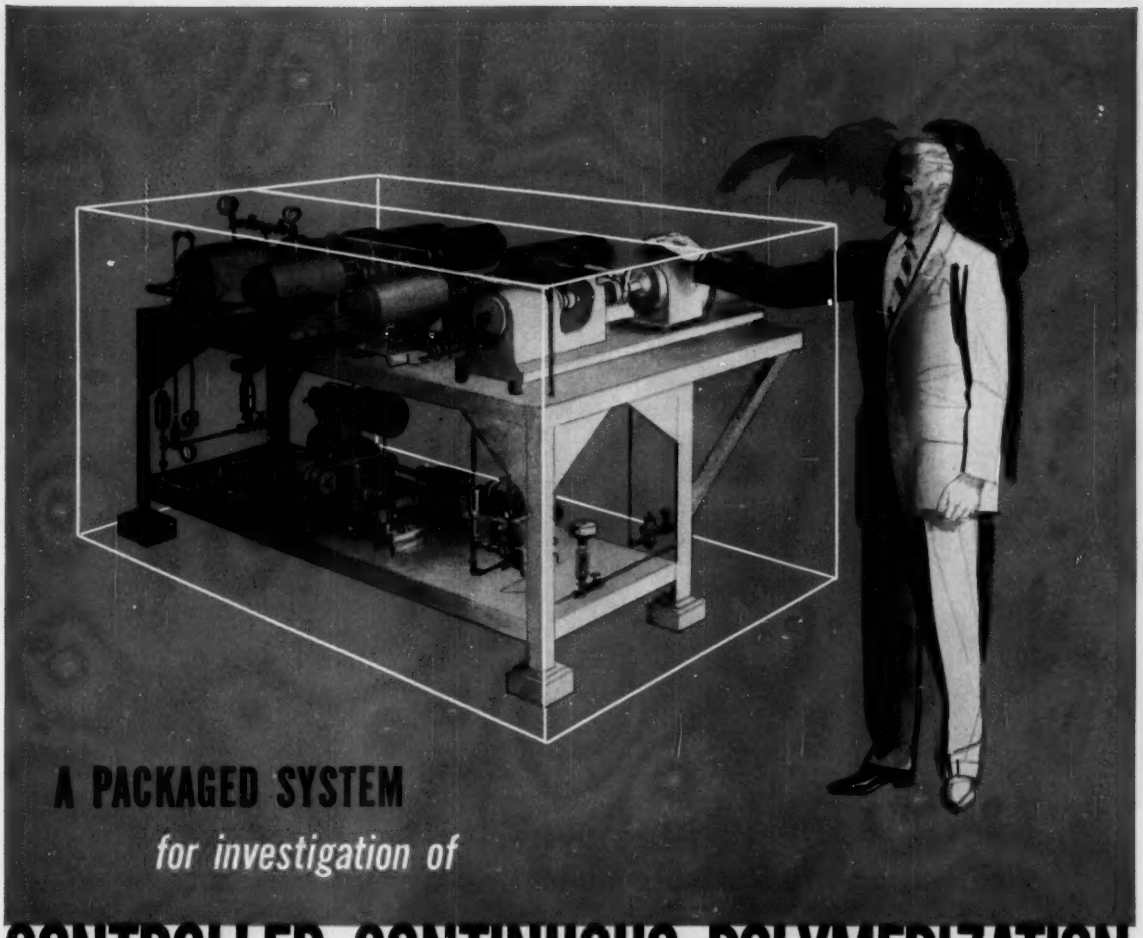
Reichhold Chemicals, Inc. has acquired the Alsynite Co. of America, a manufacturer of plastic panels reinforced with glass fiber mat. This is Reichhold's first venture in finished chemical product manufacture; Reichhold will provide the polyester resin required for panel manufacture.

OVERSEAS BRIEFS

Egypt: Construction of the giant Aswan fertilizer chemical plant is under way. Demag - Elektrometallurgie of West Germany has started erection of mammoth water electrolysis plant with 288 electrolyzers, to generate pure hydrogen for ammonia synthesis. Prime contractor, Badische Aniline und Soda Fabrik, A. G. (BASF), reports progress in the construction of the 400,000-ton/yr. calcium ammonium nitrate plant. When completed, the plant will be owned and operated by Egyptian Chemical Industries Co., (KIMA), a joint state and private enterprise.

England: Witco Chemical Co. plans construction of a 4,000-ton/yr. butadiene-styrene latices plant in the midlands of England. Witco Chemical Co., U. K., with headquarters in London will operate the new plant.

Netherlands: Heyden Newport International has acquired the nation's leading producer of rosin, N. V. Transicol. Thus Heyden Newport establishes paper-size manufac-



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Girdler's experienced engineers operate extensive pilot facilities to provide exact specifications for scaling up to production equipment. VOTATOR engineered systems are designed to meet your own specific process requirements. These systems provide a high degree of flexibility and versatility. They save materials, use less floor space and assure significant overall operating economy.

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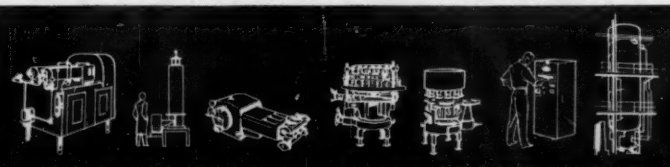

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Pressure systems may be protected with relief valves—being sized for normal overpressure conditions. However, there are times when relief valve capacity cannot handle overpressure buildups fast enough. Or valves may not function properly because of corrosion or "freeze-ups."

For standby relief, BS&B Safety Heads are the answer.

The BS&B Safety Head relieves undesirable pressure build-ups instantly, rapidly reducing pressure within a system to a safe zone of operation.

BS&B sales engineers will be glad to inspect your pressure systems with you and help recommend proper pressure protection of your equipment. Call your local BS&B office. Or write to Central Sales Engineering in Kansas City.

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turing facilities near its European markets.

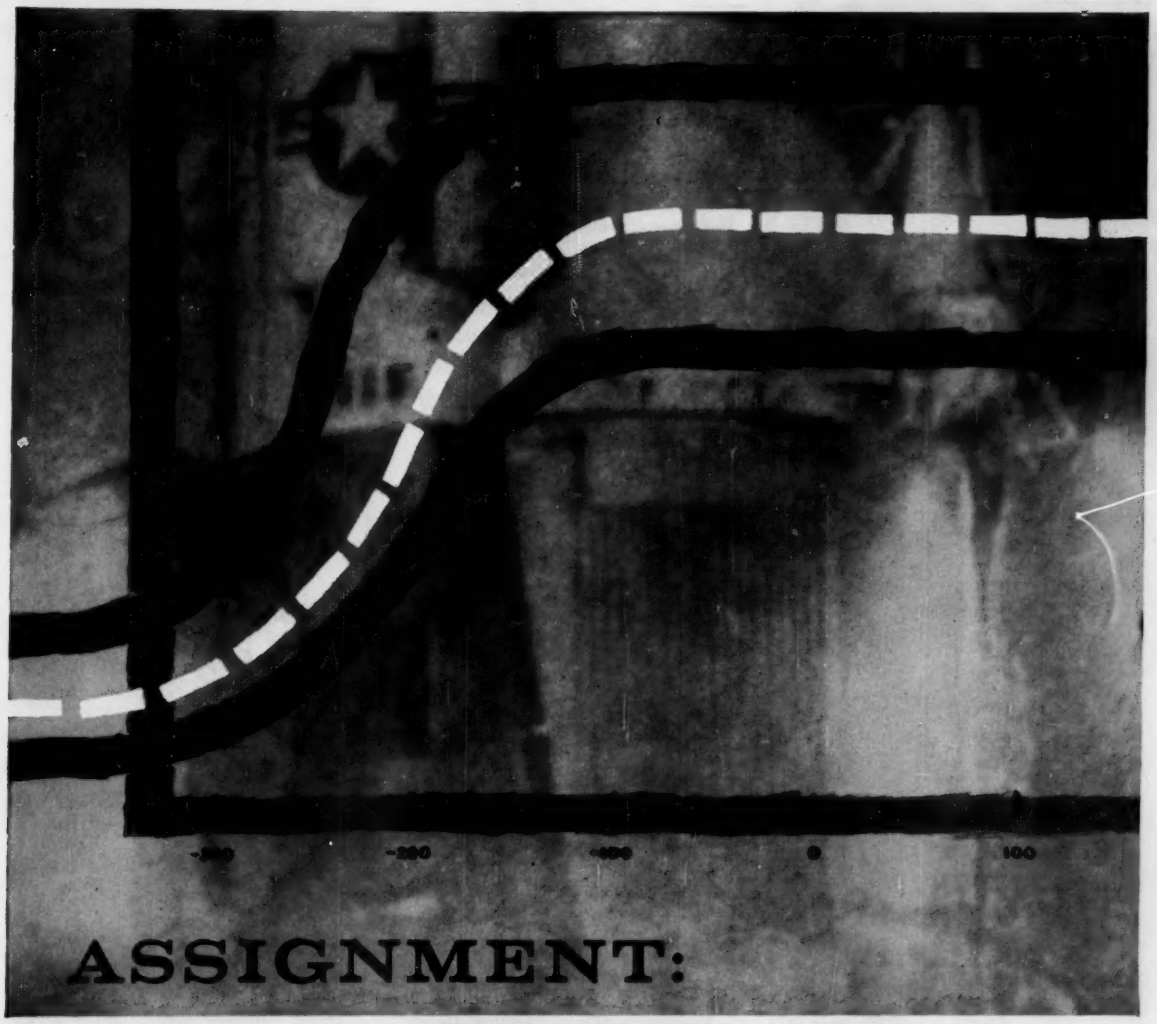
Spain: Ferro Corporation, Cleveland, Ohio, is teaming up with the Spanish firm, Uniquinesa, to establish production facilities for enamel, varnish and dyes. Concurrent with this development, the State Agency, Calvo Sotelo, has authorized construction of a $300,000 oil-dewaxing plant at the Puertollano chemical complex.

West Germany: Pintsch Bamag, A.G., has completed construction of two plants for drying of natural gas by ethylene glycols, at Rheden. Each can handle up to 150,000 cu. m./day of natural gas and features regeneration of used glycol.

Russia: Construction of a giant synthetic-fiber chemicals complex nears completion near Stalinogorsk, south of Moscow. German firm, Krupp, is putting the last wraps on a dimethyl terephthalate plant at Stalinogorsk, a paraxylene plant at Nowo-Kuibyschewsk and a fiber-spinning plant at Kusk. Final product will be a mixture of dimethyl terephthalate and wool fibers.

England: The Steel Company of Wales, Ltd. and Lincolnshire Chemical Company, Ltd. have joined together to form Port Talbot Chemical Co., Ltd. New firm will operate a new, $1.4-million hydrorefining plant at the Port Talbot steel works, to convert benzol to 4.5-million gal./yr. of benzene. Simon Carves will erect the plant, to be supplied by Lurgi.

Scotland: British Hydrocarbon Chemicals, Ltd. has placed on stream its $11.2-million cumene-phenol plant at New Grangemouth. Plant employs The Distillers Company process for direct conversion of cumene to phenol, is the first of its kind in the United Kingdom. BHC will supply the European phenol market with this plant's 13,000-ton/yr. output.



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How Lukens *Application Research* helps you find the right steel plate for the job

If your assignment is designing equipment for extreme low temperature service—our Application Engineering staff can help you. They research problems of every description from the design stage right through to how the equipment has performed for years after its installation.

Missile components and liquefied gas tanks would be dangerously susceptible to cracking if made from ordinary steel. Seeking economical metals for such applications, Lukens engineers began years ago to watch the performance of nickel bearing alloys in a variety of low temperature equipment. Result: a broad understanding of metal behavior at various low temperature levels.

Examples: In the storage of liquefied oxygen, a tank of *Nine Nickel steel* provided more than eight years of trouble-free performance. Suitable to minus 320°F. service the steel showed no signs of cracking when removed for inspection. In frigid chambers for testing high altitude aircraft, *2½ percent nickel steel* is standing up well under pressures as high as 7,000,000 pounds. And in arctic locomotives operating at temperatures to minus 50°F. on rugged mountain roadbeds, main structures of *Lukens "T-1" Steel* have required no maintenance whatsoever.

Lukens Application Engineers know these cases . . . plus many more. *If your assignment is cryogenics, why not let it be our assignment, too?* Contact Manager, Application Engineering, H-50, Services Building, Lukens Steel Company, Coatesville, Pa.

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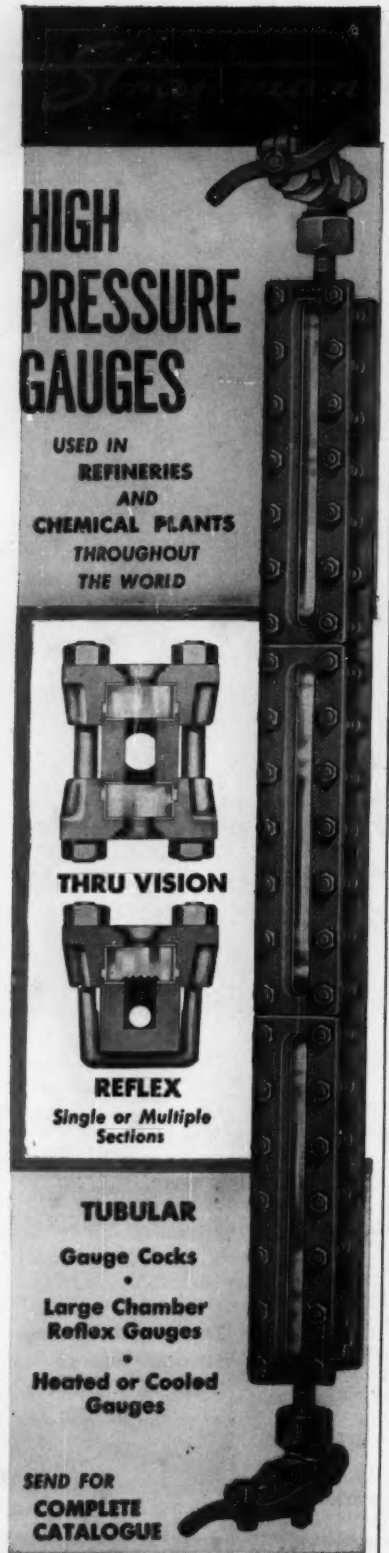


CALENDAR

Instrument Society of America, Wilmington Section, national symposium: safety in electrical instrumentation, du Pont Country Club.
May 2-3 Wilmington, Del.

Western Joint Computer Conference, Fairmont Hotel.
May 2-6 San Francisco, Calif.

Canadian Dept. of Mines and Technical Surveys, Conference: Methods of Reducing Iron Ores, Lasalle Hotel.
May 3-5 Chicago, Ill.

Society of Chemical Industry, Chemical Engineering Group, international symposium on distillation, The Dome.
May 4-6 Brighton, England

Instrument Society of America, Instrument-Automation Conference and Exhibit, Brooke Hall and Civic Auditorium.
May 9-12 San Francisco, Calif.

Oklahoma State University, Industrial Operations Analysis Conference.
May 9-11 Stillwater, Okla.

Southwestern Metal Congress, and Exposition, Sheraton-Dallas Hotel and State Fair Park.
May 9-13 Dallas, Tex.

National Assn. of Corrosion Engineers, workshop clinic: organic coatings on ferrous surfaces, Hotel Niagara.
May 11-13 Niagara Falls, N. Y.

Fluid Controls Institute, Spring meeting. The Greenbrier.
May 11-14 White Sulphur Springs, W. Va.

American Institute of Industrial Engineers, annual meeting, Dallas Sheraton Hotel.
May 12-14 **Dallas, Tex.**

Southern Methodist University, lecture series: Heat Transfer in Electronics and Direct Conversion of Heat to Electricity.
May 13-14 Dallas, Tex.

United States Army, national power sources conference.
May 17-19 Fort Monmouth, N. J.

Society for Experimental Stress Analysis, Spring meeting. Hotel Severin.
May 18-19 Indianapolis, Ind.

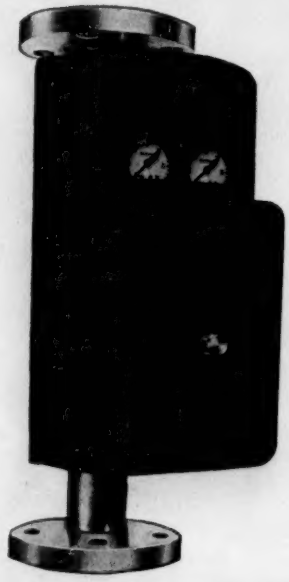
American Gas Assn., Production meeting, Roosevelt Hotel.
May 23-24 New York, N. Y.

American Society for Quality Control, annual convention, Sheraton Hotel.
May 23-25 San Francisco, Calif.

Technical Assn. of the Pulp and Paper Industry, annual Coatings Conference, Edgewater Beach Hotel.
May 23-25 Chicago, Ill.

Design Engineering Conference and Exhibit, sponsored by American Society of Mechancial Engineers, Statler-Hilton Hotel and Coliseum.
May 23-26 New York, N. Y.

MAGPNUTRAX* FLOWMETER



No extension troubles—ever! (No extension—that's why!) No sludge-catching elbows or stagnant pockets, either. With this new rotameter-transmitter the flow goes straight through. Neat as you please. Even if you're metering slurries, still bottoms and other such gunky stuff. Transmits electrically or pneumatically, however you like, and can include flow integration, too. A word from you will bring Design Specification Sheet DS-361. It tells you what you'll want to know.

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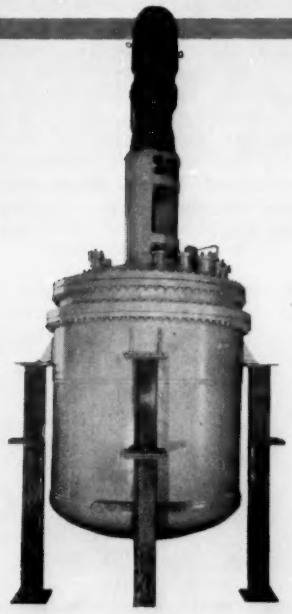
REACTION VESSELS

designed and built

BY BETHLEHEM

assure

- **lower first cost!**
- **less maintenance!**
- **fewer shutdowns!**



For the Reaction Vessel above, complete with agitator and drive, a special cast iron composition was selected to increase life. Extremely low maintenance costs were made possible by use of a Stellited shaft in the stuffing box to avoid scoring and wearing of shaft by packing. Heavy duty gear reducer with minimum bearing runout, drives the agitator shaft. Replacement or adjustment of bearings can readily be made without lengthy shutdowns or expensive repairs.

Bethlehem manufactures Vessels in cast iron and fabricated steel, stainless steel, alloys, and clad to ASME codes and to the highest specifications and standards. X-ray is just one of the techniques used to insure sound construction for demanding service. WE INVITE YOUR INQUIRIES.

See 8-page catalog in C. E. C. for complete facilities of

Process Equipment Division of

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BETHLEHEM, PENNA.

Instrument Society of America, Instrumental Analysis Symposium.
June 1-3 Montreal, Que.

Vacuum Metallurgy Conference, New York University Engineering School.
June 2-3 New York, N. Y.

American Society of Mechanical Engineers, semi-annual meeting, Statler-Hilton Hotel.
June 5-9 Dallas, Tex.

Society of Plastics Industry, annual plastics exposition, Coliseum.
June 5-9 New York, N. Y.

National Society of Professional Engineers, annual meeting, Statler-Hilton Hotel.
June 9-11 Boston, Mass.

Manufacturing Chemists Assn., annual meeting, The Greenbrier.
June 9-11
White Sulphur Springs, W. Va.

Achema congress and exposition of chemical engineering.
June 9-17
Frankfurt am Main, W. Germ.

International Powder Metallurgy Conference, sponsored by American Institute of Mining, Metallurgical and Petroleum Engineers, Hotel Biltmore.
June 13-15 New York, N. Y.

American Nuclear Society, national meeting, Palmer House.
June 12-15 Chicago, Ill.

Industrial Pharmaceutical Research Conference: Stabilization of Pharmaceutical Chemicals; King's Gateway.
June 12-15 Land O'Lakes, Wis.

American Assn. of Cost Engineers, annual meeting, Rice Hotel.
June 13-15 Houston, Tex.

Chemical Institute of Canada, annual conference and exhibition, Chateau Laurier.
June 13-15 Ottawa, Ont.

Technical Assn. of the Pulp and Paper Industry, Pulp Bleaching Conference, Edgewater Beach Hotel.
June 14-16 Chicago, Ill.

Dechema, annual meeting and exhibition.
June 14-16
Frankfurt am Main, W. Germ.

Heat Transfer and Fluid Mechanics Institute, Stanford University.
June 15-17 Palo Alto, Calif.

Gordon Research Conference: Chemistry of Coal, New Hampton School.
June 15-17 New Hampton, N. H.

British Scientific Instrument Manufacturer's Assn., international exhibition and conference.
June 16-26 Moscow, U. S. S. R.

American Institute of Chemical Engineers, national meeting, Del Prado Hotel.
June 19-22 Mexico City, Mexico

American Society for Engineering Education, annual meeting, Purdue University.
June 20-24 West Lafayette, Ind.

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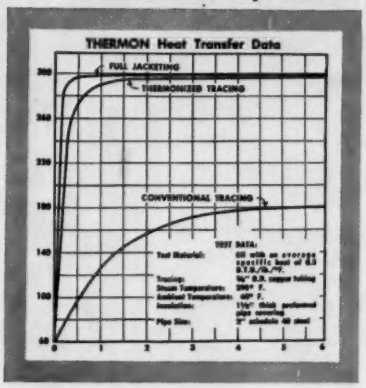
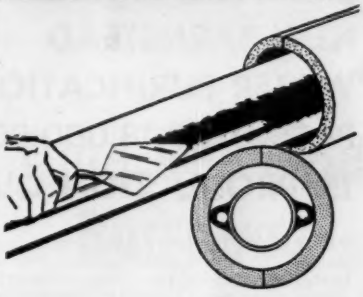
the proved solution to HEAT TRANSFER problems





Wherever heat transfer is a problem, non-metallic, adhesive Thermon Heat Transfer Cement, with its highly efficient heat transfer properties, usually can effect a solution. Approximately 5,000 different users, with hundreds of applications, have realized savings of up to 90% with Thermon.

Thermon can easily be applied over both steam tracing and electrical resistance systems, and is equally effective for heating and cooling operations.

Thermon's heat transfer characteristics are approximately *11 times* superior to those of steam tracing, and almost equal those of steam jacketing. Almost without exception, Thermon can be used in place of expensive steam jacketing—and can often be applied where steam jacketing is impossible. Up to 90% of the cost of steam jacketed equipment has been saved through use of Thermon.

Write for Thermon Bulletin 300.

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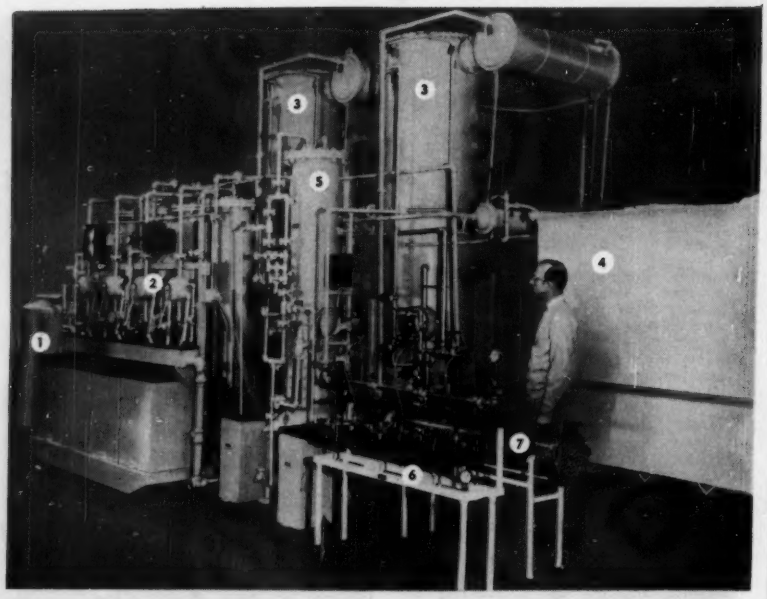

NEW BARNSTEAD WATER PURIFICATION EQUIPMENT PRODUCES 18,000,000 OHM WATER IN PRODUCTION QUANTITIES.

PROBLEM: A large electronics firm needed 18,000,000 ohm* water free of bacteria, organics, silica, and submicroscopic particles. Existing purification methods could not produce it in either the purity required nor in the quantities needed. Further, the slightest amount of impurities in the firm's rinsing and washing operations would result in a high rate of rejects, raised manufacturing costs, and in some cases a permanently damaged product, noticeable when in use by the ultimate consumer.

SOLUTION: Since demineralizers would provide high ionic purity but would not solve the problem of bacteria, colloidal impurities, dissolved gasses, organic matter etc., the use of distillation combined with other purification methods became necessary. Barnstead recommended the following equipment operating in series. 1. Sand and carbon filter for preliminary treatment of raw water. 2. A four-bed, extra-high capacity demineralizer for removal of most ionizable impurities. 3. Two Barnstead new high-purity Stills to remove the remaining non-ionizable, suspended, and gaseous impurities. 4. Box-type tin-lined tank for intermediate storage. 5. Mixed-bed demineralizer for removal of final traces of ionizable impurities. 6. Barnstead MF® Submicron Filter for removal of submicroscopic particles down to 0.45 micron. 7. Tin-lined heater for final heating of water to desired temperature for manufacturing operation.

RESULT: This Barnstead Pure Water Equipment, especially designed for this particular manufacturing operation, produces 18,000,000 ohm water completely free of bacteria, organics, silica, and submicroscopic particles. Thus a new manufacturing procedure becomes a reality through Barnstead Pure Water Engineering.
If you need Pure Water, in either laboratory amounts or production quantities, come to Barnstead with your problem . . . Pure Water Specialists Since 1878.

NEW PURE WATER LITERATURE

Catalog "G" describes Barnstead Water Stills in capacities of from ½ to 1000 g.p.h. Catalog 127 on Barnstead Mixed-Bed, Two-Bed, and Four-Bed Demineralizers. Bulletin 141 describes Barnstead MF® Submicron Filter for filtering out particles down to 0.45 micron.

***temperature corrected to 25 C.**

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NEW YORK — KIngsbridge 8-1557
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(*Continued from page* 86)

known as RIMA is available for screening, sifting, dewatering, sizing, washing and filtering operations. The high-narrow profiles of the wire give more working screen surface than other shaped-wire screens, increasing percentage open area and screening capacity.

Furnished in rectangular, oblique angled, round and oval beds with sharp or round bends, RIMA screens come with stainless steel or carbon steel materials of construction. Conical segments, cylindrical troughs and other special shapes are available. Slit widths down to 0.002 in. are offered.—**Cross Perforated Metals Plant, National-Standard Co., Carbondale, Pa.** **86D**

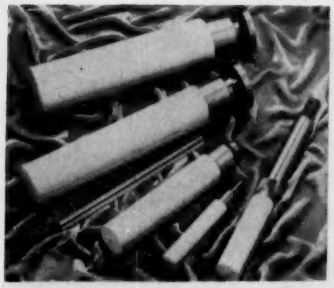
Electronic Thermometer

New instrument leads assure greater accuracy.

Accurate temperature measurements of liquids at depths from a few feet to thousands of feet is now possible by means of long lead length developed for use with A+ Thermophil instruments. These leads are available in any length for measurement of the various temperature layers that form when water, petroleum byproducts, liquid chemicals and other fluids stratify.

Temperature measurement errors associated with lead length are insignificant because the temperature-sensing resistant bead has a very high impedance (several hundred thousand ohms) that changes rapidly with each degree of temperature variation. The lead is completely water-, oil- and abra-

sion-resistant. Permissible temperature range for the lead is −148 to 554 F.—**Atkins Technical, Inc., Cleveland, Ohio.** 166A

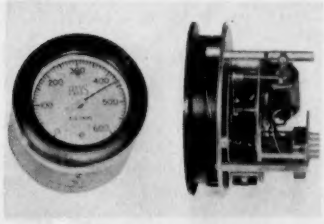


Pump Pistons

Have precision-finished ceramic surfaces.

Made of high-alumina ceramic, a new line of pump pistons is offered for applications where corrosion and physical abrasion problems preclude the use of metal pistons. Piston sizes range up to 3 in., with tolerances of ±0.0002.

Maximum length of the ceramic portion for any piston is 14 in. Surface finish is better than 16 micro-in., and concentricity is 0.002-0.003 total indicator reading. Metal attachments are machined to specifications.—**Centralab, Milwaukee, Wis.** 167A

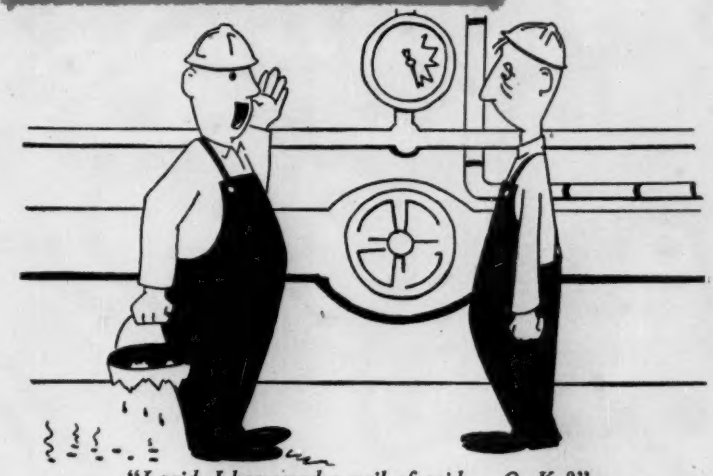


Remote Receiver

New receiver completes electrical control line.

Remote indications of gas and liquid pressure, draft, differential pressure, flow, temperature and liquid level are typical functions of a new all-electric round-dial receiver. A three-wire transmission line is the

Life in these excited states...



"I said, I borrowed a pail of acid... O. K.?"

High-impact, rubber-plastic, most economical for average chemicals. ½ to 6". Screw or solvent welded fittings. Valves ½ to 2". NSF-approved. *Bul. 80A.*

Rubber or plastic lining is economical life insurance for costly "special" equipment. It's a specialty with ACE. Write for *Bul. CE-53.*

Choice of Riviclor PVC, Ace-Ite rubber-plastic, Ace polyethylene or Ace Saran to match *any* plastic pipe. Sizes ½ to 2". Also larger plastic-lined valves.

Time Can't Be Borrowed Either

Equipment running on borrowed time due to corrosion has a knack of dropping the bottom out of production when you can least afford it. No need to risk it... just specify Ace chemical resistant equipment. Best for the money anywhere... backed by 108 years' experience.

Ace-Hide, tough as a rhinoceros, insensitive to corrosives, makes this finest of acid pails. Also dippers, bottles, funnels, etc.

ACE *chemical resistant equipment*
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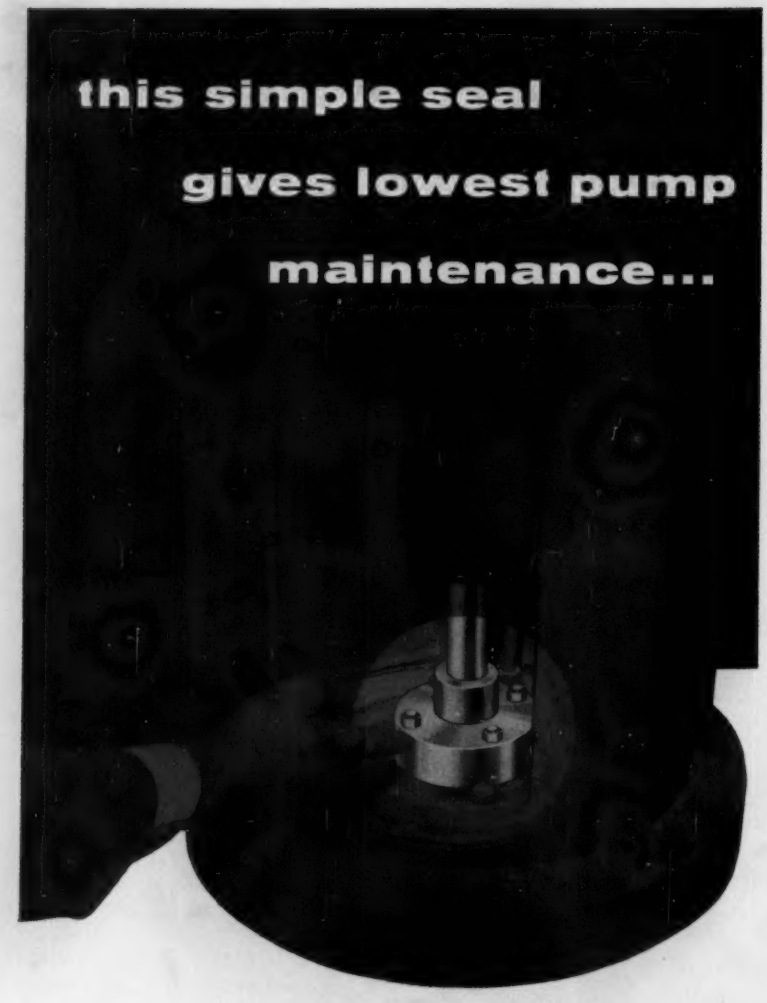
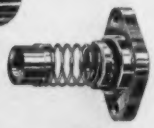
See ACE equipment in Chemical Engineering Catalog



Save up to 66% of the time—expensive downtime—needed for installation or service of other mechanical seals used in plant process equipment.

The simple, effective Borg-Warner Type U Seal has no set screws—no close spring tension adjustments. It's fast and reliable.

For plants with a wide variety of pump service requirements, a minimum inventory of parts, and an easy change of gaskets adapts the Type U seal for service at temperatures of from −100 below zero to +650°F, and for pressures from 0 to 1000 psi.



Backed by Borg-Warner and proved in service, these dependable seals give complete safety, even in unattended stations.

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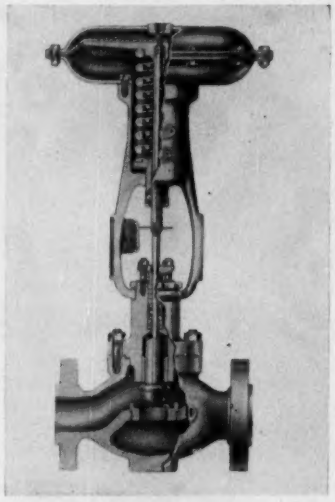
Borg-Warner Mechanical Seals

P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

only required connection between a transmitter and the receiver; a plug-in connector to the amplifier is its only external connection. Known as the Model 731, the instrument has great speed of response (2.5 sec. for full-scale travel).

Sensitivity is described by the manufacturer as 0.1% of full range or better, with calibrated accuracy for flow being ±1% of full-range scale. For low, medium or high pressure, as well as temperature, calibrated accuracy is ±2%. Three sizes are available to fit most industrial requirements: 4½, 6 and 8½ in.—**The Hays Corp., Michigan City, Ind.** **167B**



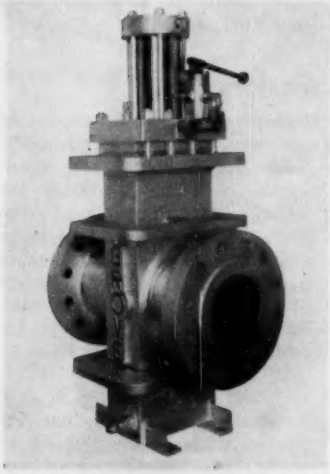
Control Valve

Meet requirements of modern processing applications.

High capacity, ability to handle high pressures and pressure drops, and a wide selection of reduced capacity trim are among the features of the new 20000 Series single-seated control valves. Design incorporates a top-guided, unrestricted seat-ring area with body and plug contours that provide greater capacity than most similar valves of comparable size.

Additional advantages include wide selection of materials to meet severe operating conditions, design of body and plug contours to make the unit

suitable for viscous fluids and slurries, and a choice of either screwed, flanged, or welded ends. Sizes: ¾ to 10 in.—**Mason-Neilan, Norwood, Mass.**



Pipeline Valve

Piston - cylinder operator and valve combination.

Designed primarily for gas pipelines, the new Grove valve operator combination provides extremely fast operation, and claims a sharp reduction in over-all size. Utilizing line pressure, gas is applied to either end of the piston cylinders, thus moving the piston to either open or closed position.

A variable orifice on the exhaust side of a four-way valve controls operating speed. On all models, a parallel-faced gate lies between floating seats. Metal seal rings and nitrile rubber O-rings accomplish the seal; no lubrication is required. —**Grove Valve & Regulator Co., Oakland, Calif.** 169A

Shutoff Damper

When open, passage of gas is entirely unimpeded.

Consisting of a housing, a valve disk, and an operating device, a new shutoff damper for flue gas ducts is claimed to be absolutely tight-fitting and very

WIRE CLOTH

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FILTERING

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In all metals, in all weaves ... woven to the highest accuracy standard in the industry. You just can't buy a better wire cloth than "NEWARK." Hundreds of meshes, weaves and metals to fit your specific need. Years of processing experience to help you pick the right wire cloth for your application. Write for Bulletin FC or write us about your problem. Fast deliveries, best cloth, lowest cost when you call on NEWARK.

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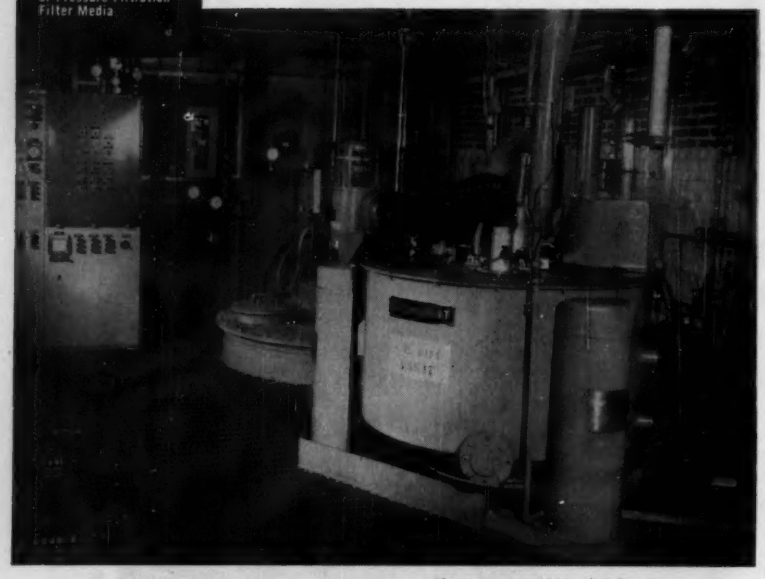

Photo courtesy of Merck & Co., Inc.

BATCH-O-MATIC® PROVIDES
EFFICIENCY AND CONSTANT QUALITY CONTROL

The completely automated BATCH-O-MATIC reduces exposure time to maintain product stability in centrifugal extractor operations. They can be constructed of stainless steel, "Hastelloy", titanium or other alloys. Corrosion-resistant coatings may be specified.

Low, compact design and exclusive CENTER-SLUNG® suspension enable BATCH-O-MATIC to handle greater out-of-balance loads with minimum vibration. Low-speed plowing prevents crystal degradation. See complete data in the TOLHURST section in Chemical Engineering Catalog, or write Dept. CET-560 for free bulletins.

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simple in operation. No dust from the flue gases can accumulate to obstruct proper function of the damper.

As designed, the damper installs readily in various systems of flue ducts. Standard sizes vary from 6,000 to 250,000 cfm. —**American SF Products, Inc., New York, N. Y.** 169B

BRIEFS

High-pressure hose made of transparent polyvinyl chloride, reinforced with open-mesh nylon, is available for working temperatures from −5 F. to 170 F. Bursting pressure of ⅛ in. I.D. type is 1,500 psi.; that for ½ in. is 800 psi. Maximum size available is 1¼ in.—**Newage Industries, Jenkintown, Pa.** 170A

Pneumatic cushion, when inflated with a pressure of 45 psig., exerts a force of approximately 56,000 lb. for elimination of flow stoppages in bins and hoppers. Unit consists of a rubber diaphragm bolted to a reinforced steel base equipped with both inlet and exhaust valves.—**Tressler Engineering Products Div., New York, N. Y.** 170B

Pneumatic rappers with patented one-piece design eliminate 80% of maintenance problems on precipitators and dust collectors, according to the manufacturer. Navco rappers have no assembly bolts to stretch and shear, or separate striking plate to leak air from housing. Air consumption at 50 psi. is only 9 cfm. —**National Air Vibrator Co., Cleveland, Ohio.** 170C

Demonstration laboratory of Turbo-Mill manufacturer is now open for pilot-plant runs. Turbo-Mill, a machine for pulverizing, grinding and defibering, combines the principles of operation of the hammer mill and the disk mill. — **Pallmann Pulverizers Co., Inc., Hoboken, N. J.** 170D

High-voltage switch between rectifiers and electrodes of electrostatic precipitators

features multideck rotary design. Unit may be housed in its own compartment, or within the transformer-rectifier compartment. Operation limitations are 100,000 v. and 1 amp. Provisions are included for use of safety-key interlocks.—**Buell Engineering Co., Inc., N. Y., N. Y.** 170E

Foamed-plastic pipe insulation claims new design improvements that give it a higher temperature range, complete ozone resistance and smoother surface for easier handling and better appearance. Called Armaflex 22, the product is useful for temperatures from below zero to 220 F. Three wall thicknesses offered.—**Armstrong Cork Co., Lancaster, Pa** 171A

Rupture disk protects against implosion and explosion at the same time—at any pressure to 150 psi. Each burst setting can be different from the other. Designated as "D" disk, the products are accurate to ±5% of rated burst, even at low pressures to 10 psi. Maximum temperature is 650 F.—**Falls Industries, Inc., Solon, Ohio.** 171B

Equipment Cost Indexes . . .

	Sept. 1959	Dec. 1959
Industry		
Avg. of all	235.8	237.0
Process Industries		
Cement mfg.	229.9	231.1
Chemical	237.5	239.0
Clay Products	223.4	224.6
Glass mfg.	224.2	225.6
Paint mfg.	228.0	228.7
Paper mfg.	228.8	230.2
Petroleum ind.	232.9	233.6
Rubber ind.	235.7	236.5
Process ind. avg.	234.1	235.4
Related Industries		
Elec. power equip.	239.4	242.1
Mining, milling	239.0	240.4
Refrigerating	266.4	267.3
Steam power	223.2	223.9

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

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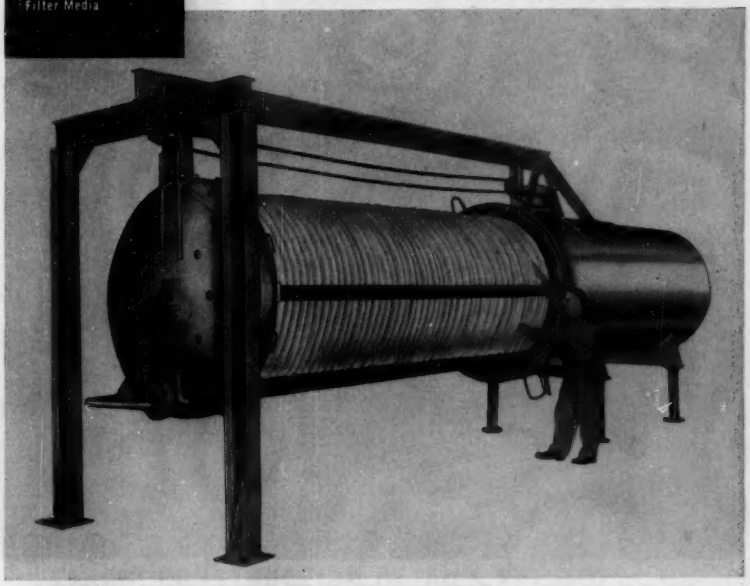

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Adaptable, versatile NIAGARA FILTERS minimize downtime. Steady production line filtration with speed and efficiency is attained with fully automated models of NIAGARA FILTERS.

- **SPEED** . . . Save time and boost production with these NIAGARA advantages: fast wet or dry cake removal without manual labor; highest flow rates result of advanced hydraulic design.
- **EFFICIENCY** . . . Operating with process streams from 5 to over 1,000 gallons per minute, NIAGARA FILTERS can be adapted to automatically process hundreds of materials. Complete data in NIAGARA section of Chemical Engineering Catalog, or write Dept. CEN-560 for free bulletins.

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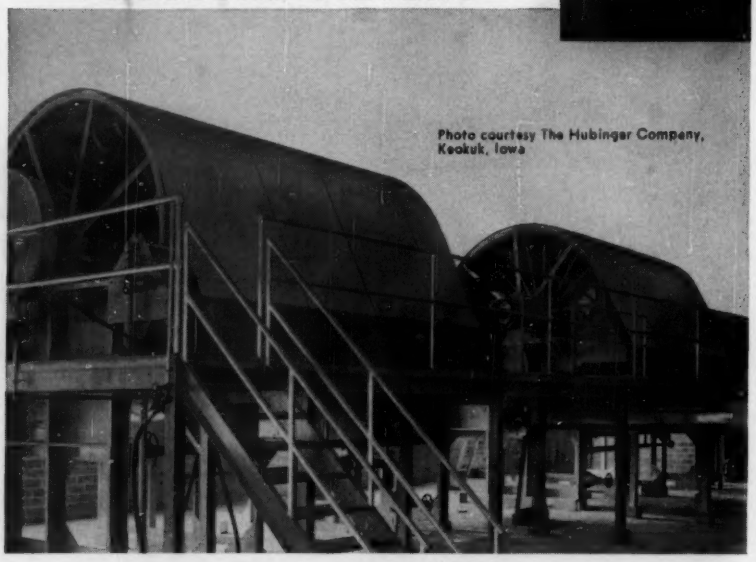

Photo courtesy The Hubinger Company, Keokuk, Iowa

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FEINC *custom designs* every filter for the specific application. This insures greater yield with less downtime over longer periods of continuous operation. Standard sizes range from 5 to 800 sq. ft. of filtering area.

The FEINC STRING DISCHARGE filter eliminates blow-back and produces a cake of low moisture content. PRECOAT filters give high clarity of effluent and flow rates. A complete line of SCRAPER and ROLLER DISCHARGE filters is available. The HORIZONTAL filter offers extremely high hourly output. See complete data in the FEINC section in Chemical Engineering Catalog, or write Dept. CEFE-560 for free bulletins.

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FE INC®

TECHNICAL

For Process Industries

INDUSTRIAL INSTRUMENT SERVICING HANDBOOK. By G. C. Carroll. McGraw-Hill Book Co., New York. 886 pages. $16.

Reviewed by H. M. Schenk, Leeds & Northrup Co., Philadelphia, Pa.

Mr. Carroll has compiled an extensive handbook of over 800 pages that should prove useful in every company with enough instrumentation to maintain a separate instrument shop. It provides theory, maintenance hints and trouble-shooting tables with a uniformity of approach that is certainly lacking when one goes from one manufacturer's instructions to another. The handbook also recommends spare parts likely to be needed. This information is necessary for the maximum usefulness of any equipment, yet is often omitted in direction books.

The choice of material covered in any compilation such as this is always debatable. Mr. Carroll's choices seem to be slanted toward the process industries. He covers such items as gas analysis, specific gravity and viscosity, yet makes no mention of electronic proportioning control units. He also omits any reference to millivoltmeters. Although his book carries a 1960 publishing date, it does not mention, for example, the Leeds & Northrup Speedomax Type H even though this instrument has been a large factor in industrial instrumentation since 1955.

To be of maximum use, a handbook must have a complete and easily used index. Yet this large volume has an index of just over five pages and a table of contents only a few lines over two pages. If some of the omissions pointed out are in error and the material is really there, this emphasizes the criticism of the index. Each of these items was searched for using every heading that seemed at all reasonable.

There is a myriad of instru-

BOOKSHELF

ments and many variations of each, thus the handbook must be somewhat general. It is not, therefore, a substitute for the manufacturers' instruction books and drawings. These are usually more complete and do apply to the specific instrument at hand. The handbook will, however, be a very useful supplement giving hints gained from field experience.

It seems to this reviewer that the handbook has another useful function, perhaps not anticipated. So often a new problem in instrumentation arises that involves unfamiliar concepts and/or hardware. This volume explains principles involved and provides a list of at least some of the companies able to supply the necessary equipment together with a description of the various methods of execution.

MORE NEW BOOKS

ADVANCES IN ORGANIC CHEMISTRY: METHODS AND RESULTS. Ed by A. A. Raphael, E. C. Taylor & H. Wynberg. Interscience. $12.

MECHANICAL PROPERTIES OF INTERMETALLIC COMPOUNDS. Ed. by J. H. Westbrook. Wiley. $9.50.

CALCULATIONS OF ANALYTICAL CHEMISTRY. 6th ed. By L. F. Hamilton & S. G. Simpson. McGraw-Hill. $5.95.

QUANTUM CHEMISTRY METHODS AND APPLICATIONS. By R. Daudel, R. Lefebvre & C. Moser. Interscience. $14.50.

MATRICES. By W. V. Parker & J. C. Eaves. Ronald. $7.50.

PYRIDINE AND ITS DERIVATIVES, PART 1. By R. A. Barnes, F. Brody & P. R. Ruby. Ed. by E. Klingsberg. Interscience. $49 (four parts).

HIGH TEMPERATURE TECHNOLOGY. McGraw-Hill. $15.

VACUUM PROCESSING IN METALWORKING. By J. W. Cable. Reinhold. $5.50.

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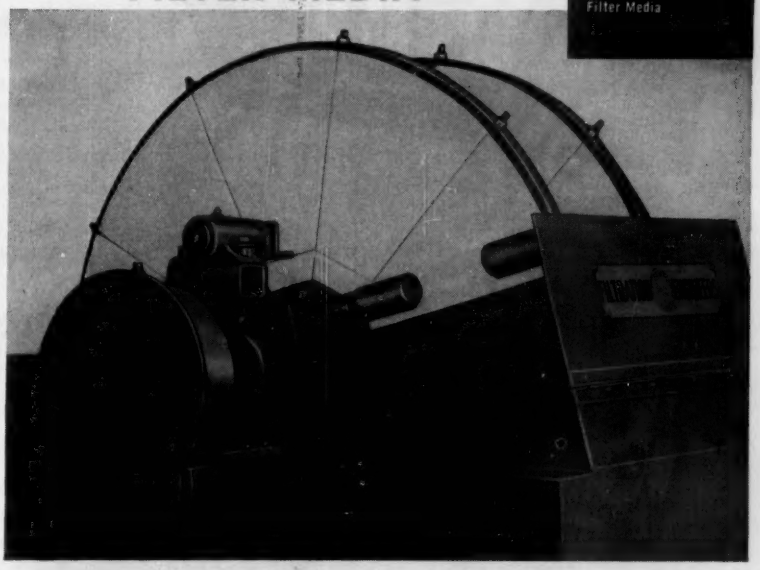

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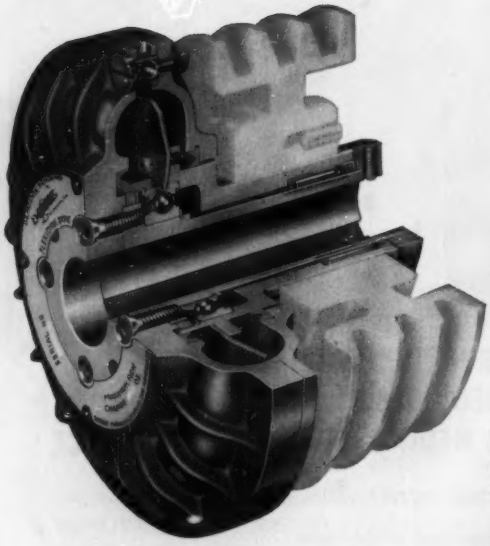

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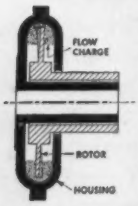
Flexidyne is available, off the shelf, in Drives and Couplings. Capacities range from fractional to 1,000 hp. Ask your local Dodge Distributor or write us for technical bulletin.

DODGE MANUFACTURING CORPORATION, 200 Union St., Mishawaka, Ind.

HOW FLEXIDYNE WORKS



The "dry fluid" in Flexidyne is tiny heat-treated steel shot. A measured amount, called the "flow charge," is contained in the housing, which is keyed to the motor shaft. Inside the housing is a rotor, free to revolve relative to the housing, but connected to the load.

When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor, which transmits power to the load. Initial slippage is momentary. Housing and rotor become locked together and achieve full load speed without slip and at 100% efficiency.

CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

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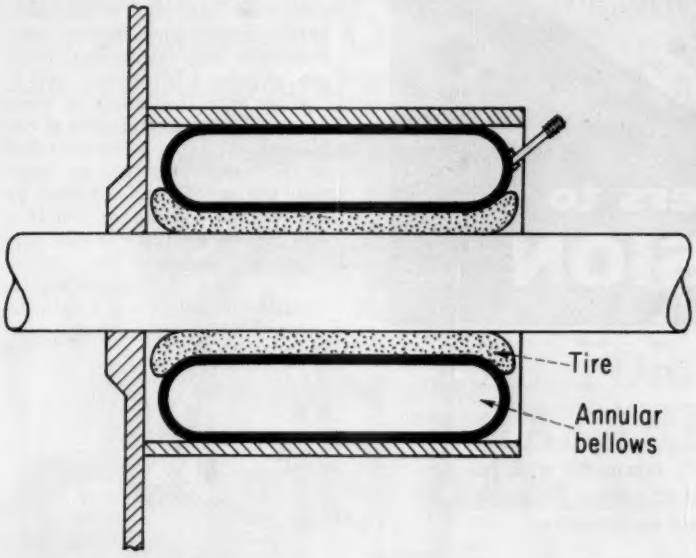
LETTERS: PRO & CON

C. H. CHILTON



New Stuffing Box Design

Sir:

Mr. L. E. Prosser's letter in your Dec. 28 issue (p. 133) makes interesting reading. But we think his proposed stuffing box arrangement gives rise to certain disadvantages.

We have worked out a new design for stuffing boxes operating at moderate temperatures. It is different in design principles and details.

In ordinary packed stuffing boxes, the principle is to obtain a radial sealing force by applying an axial pressure on a packing substance having a high Poisson's ratio.

In the proposed design (*above*), the sealing force is directly obtained by pneumatic or hydraulic pressure against a tire which contacts the shaft. The tire fits on the shaft with a medium clearance. The annular bellow presses the tire against the shaft by pneumatic or hydraulic internal pressure and seals the passage of the fluid. The contacting surface may be lubricated easily.

Teflon, silicone rubbers and other such flexible materials can be used to suit the service.

H. S. RAMA IYENGAR
M. N. SUBRAHMANYAM
Shri Ram Institute for Industrial Research
Delhi, India

Fired or Laid Off?

Sir:

I have just read your *Chementator* story, "What criteria for firing engineers?" (Mar. 7, p. 53). I was impressed with your being able to dig out a point of arbitration which would stand on its own feet and which would be of interest.

Two small points didn't come out quite the way I think they should. You reported that Dortch had the lowest record of all mechanical engineers in the entire tooling department. This is what his layoff would imply, but Boeing never explicitly contended this. His rating was lowest only in his particular group of some 50 engineers, and this was because some 35 engineers who were judged less able had already

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been transferred out of that group.

Also, you should not have used the word "fired" to describe what happened to Dortch. This word ordinarily construes unsatisfactory performance. You should have used "laid off," which ordinarily means satisfactory performance but insufficient work available.

I am sure that many of your readers who are employers of engineers are going to be horrified at the suggestion that an engineer whose job runs out must be transferred to another job if a less capable engineer is now performing that other job.

DAN N. HENDRICKS, JR.
Seattle Professional Engineering Employees Assn.
Seattle, Wash.

Pro: Foreign Literature

Sir:

The article by L. W. Ross in your Mar. 21 issue (pp. 143-148) is most appropriate. It clearly outlines the enormous information problems facing the chemical engineer and offers concrete suggestions for improvement.

Secondary literature sources of particular interest, other than those mentioned in the article, could include *Applied Mechanics Reviews* and the listings in *American Rocket Society Journal*. Titles of Russian articles of potential interest to chemical engineers are given regularly in *Chemical Engineering Science* and in several British engineering journals.

As Mr. Ross states, the value of translations of foreign articles can hardly be overestimated. We have recently had translations made of several Russian papers on boiling heat transfer which proved to be directly related to our present work, and with no direct parallel, to our

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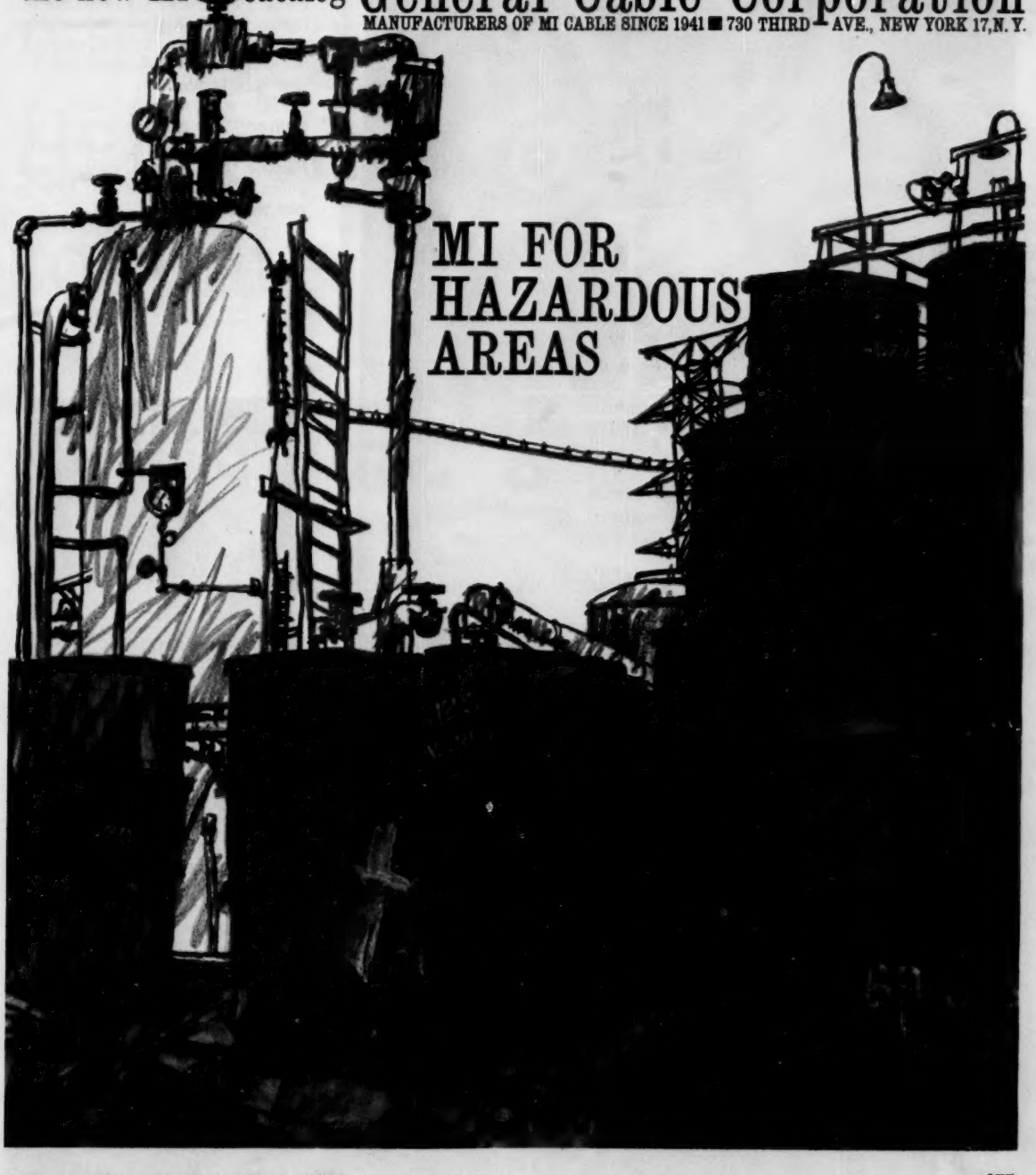

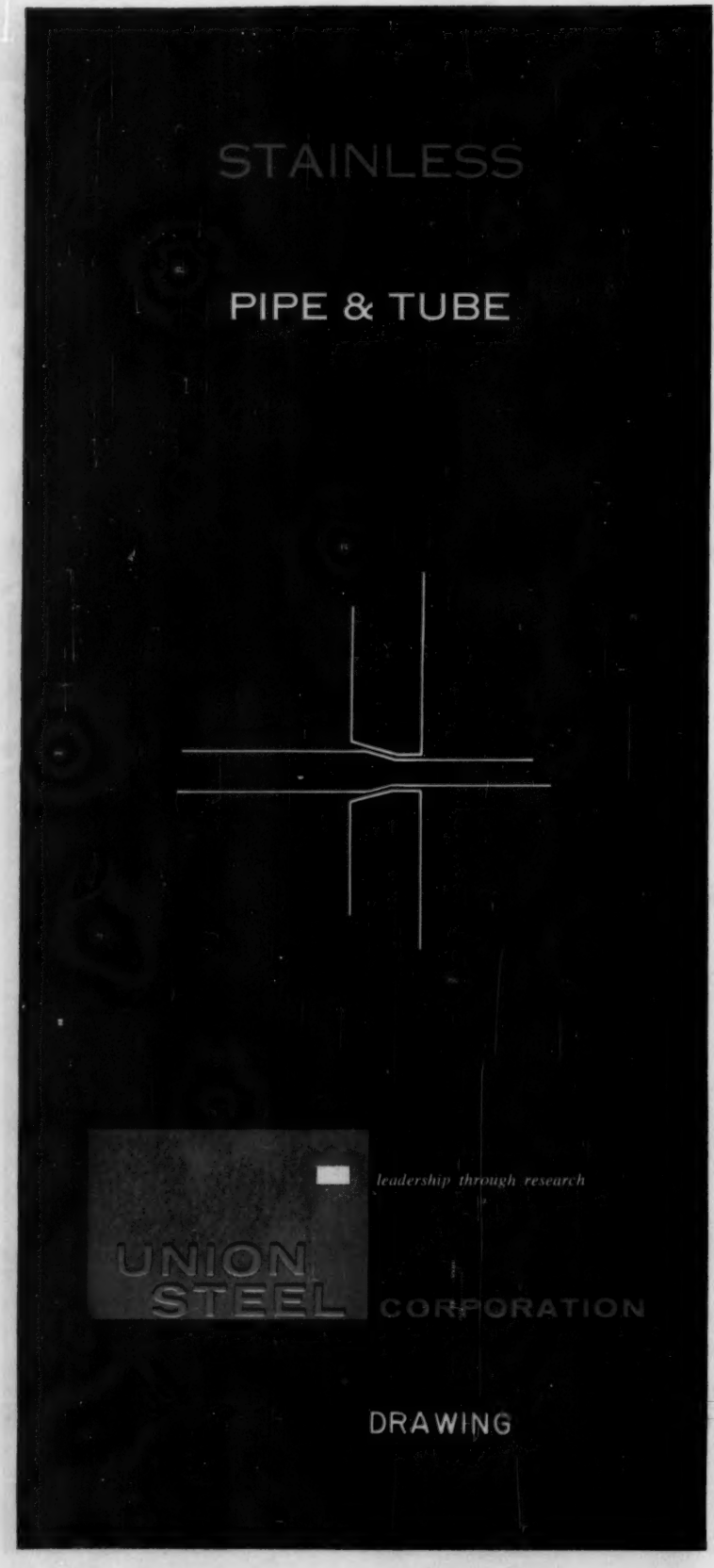

knowledge, in the U.S. literature.

W. R. GAMBILL
Oak Ridge National Laboratory
Oak Ridge, Tenn.

More Electrolytic Hydrogen

Sir:

In your Dec. 14 issue (p. 88) the water-electrolysis hydrogen plant now under construction for Nangal Fertilizer & Chemicals in India, with a hydrogen capacity of 880,000 cu. ft./hr., is reported to be the "world's largest water-electrolysis plant."

May we point out that our company's largest electrolytic hydrogen plant at Vemork near Rjukan in southern Norway produces 1,200,000 cu. ft. of hydrogen per hr.

JOHAN B. HOLTE
Norsk Hydro-Elektrisk
Kvaelstofaktieselskab
Oslo, Norway.

Pro: Technical Secretaries

Sir:

We have read with a great deal of interest "Secretaries Who Talk Your Language" in your Mar. 7 issue (pp. 148-150).

Training of technical secretaries is certainly a departure from the traditional offerings of proprietary business colleges. The owners of Business Training College are to be congratulated on making such an opportunity available to people of the Pittsburgh area.

We like to think that we were

The warning that comes too late!

WHEN THIS HAPPENS, it's already too late. Lubricant has leaked out, and dirt or grit have probably damaged your bearings and shaft.

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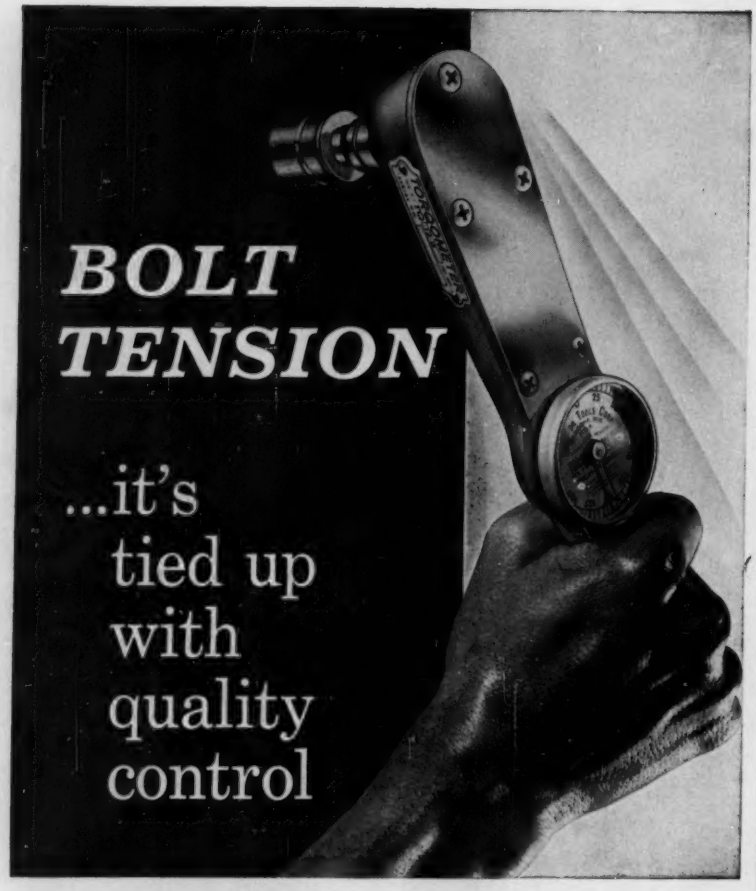

Correct tension, that is, of bolts, studs, screws, and other fasteners used in product assembly. Without tension control there is no quality control.

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pioneers in this movement for providing specialized training for secretaries in the engineering field. We have had a course of this type since 1947. In our old catalogs this was called "Technical Office Assistant." However, the terminology and course content have been rearranged somewhat, and the option now reads "Engineering Secretarial." Our graduates find employment chiefly throughout the southern tier of New York State.

A. J. KALBAUGH
Broome Technical Community College
Binghamton, N. Y.

More on Canned Pump

Sir:

In your story on our new centrifugal transfer pump (Feb. 22, p. 187), you neglected to mention that this is a "canned" type of pump. Also, it is furnished with a *stainless* steel carrying bracket, not merely steel as your article states.

R. DEUTSCHER
Sethco Mfg. Corp.
Merrick, N. Y.

Pro: Emphasis on PR

Sir:

I agree with Mr. Hartsook (Feb. 22, pp. 145-149) in that the technical societies are doing an excellent job in the dissemination of technical material but are falling far short in the development of prestige and public relations. The national societies need to put more emphasis on public relations and professional development of the individual.

Although your technical articles are very good and have their place, I most enjoy "You & Your Job" and "Pro & Con." These sections contribute personality and warmth to your pages. It is time that the engineer be recognized as a warm-blooded individual with a personality—not as a cold, hard calculating machine with a library of technical data for a brain.

JIMMY M. REAGAN
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TECHNICAL

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Chemicals

Acetonitrile.....Detailed information on acetonitrile as an extrative distillation solvent along with information on azeotropic mixtures of acetonitrile is available.
83 *Union Carbide Chemicals Co.

Anhydrous Aluminum Chloride..... Closed system protects the quality and offers safe handling. Information, including the range of screen sizes, available.
76 *Allied Chem. Solvay Process Div.

Barium Oxide.....Exception properties of porous barium oxide as a drying agent, dehydrator and desiccant given in pamphlet. Available in lump or granulated form.
184A Barium and Chemicals Inc.

Bromine.....Information on bromine and over 100 brominated compounds which can solve your problem is now available. Bromine is highly reactive.
59 *The Dow Chemical Co.

Carbon Dioxide.....24-page booklet covers history, principal applications, properties, manufacture, supply and distribution of CO_2 in gaseous, liquid and solid form.
184B Pure Carbonic Co.

Carbonate of Potash.....is shipped in 50-ton dry-chemical hopper cars designed to preserve purity. Description, typical data & specifications offered.
93c *Hooker Chemical Corp.

Catalyst.....New fluid cracking catalyst Aerocat 3-C is designed for more flexible & profitable refinery operation. Composed of silica, alumina & magnesia. Information.
12-13d *American Cyanamid Co.

Cation Exchange Resin.....Amberlite 200 features high resistance to oxidation, perfect bead form, high attrition resistance, etc. Full information and samples.
4 *Rohm & Hass Co.

*From advertisement, this issue

LITERATURE

E. M. FLYNN

Chlorinating Agents.....The 24-page technical Bulletin 328-B describes typical reactions of sulfur monochloride and many other chlorides. Compare physical properties.
93b *Hooker Chemical Corp.

Cobalt Compounds.....Summary lists 46 organic and inorganic compounds and provides information on uses, formula, per cent cobalt, molecular weight and other data.
185A Cobalt Information Center

Compounds.....Drum quantities of Dialkyl Cyanamides are available for the synthesis of substituted guanidines, biguanides, normal & isoureas, and thioureas.
12-13e *American Cyanamid Co.

Dyeing Agent.....Calco Leveling Salt eliminates objectionable striped or Barre effects encountered in dyeing wood carpeting. Allows colorant to dye rather than stain fiber.
12-13c *American Cyanamid Co.

Epoxy Adhesive Binder.....32-page handbook of application methods describes concrete adhesive bonding agent for use with both new and old concrete.
185B International Epoxy Corp.

Film Coatings.....Brochure tells how application of todays' unique materials as thin film coatings can solve product and production problems. Gives examples of uses.
185C National Glaco Chem. Corp.

Fluorides.....Major uses of Fluorides are in the petroleum, glass, steel and atomic energy industries. The newest fluoride is silicon tetrafluoride.
37 *The Harshaw Chemical Co.

Fuel Cells.....12-page booklet discusses basic facts about fuel cells including how they work, problem areas, various types under development and technical performance.
185D General Electric Co.

Inorganic Insulation.....Bulletin gives technical information and tables describing rigid inorganic insulating material composed of special glass reinforced with mica.
185E Haveg Industries, Inc.

* From advertisement, this issue

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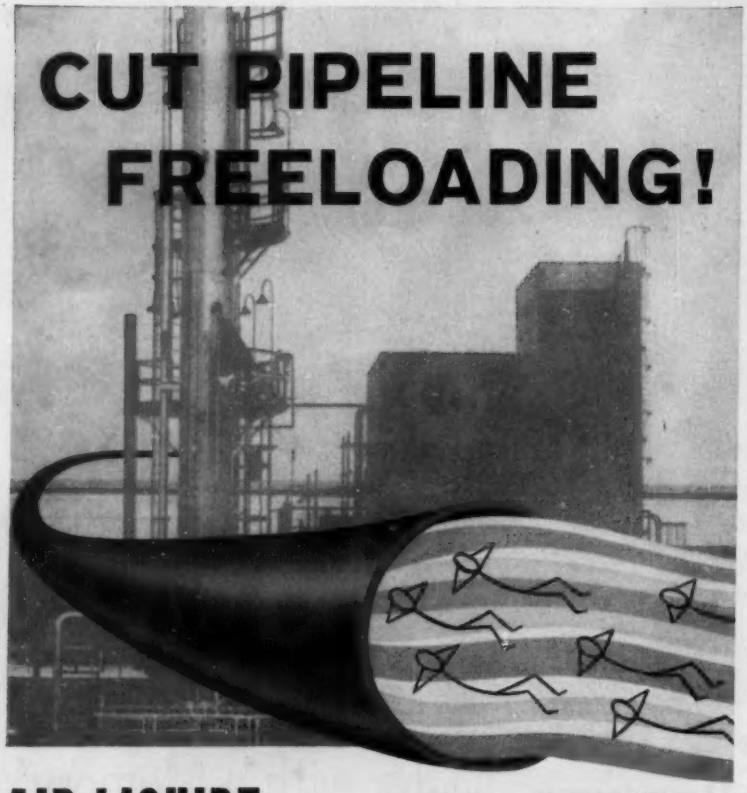

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LITERATURE . . .

MBTS Accelerator.....makes possible such process savings as: shorter mixing cycles, lower reject rates, better dispersion, elimination of refining & master-batching.
12-13b *American Cyanamid Co.

Melamime Acrylic Resin.....Melaqua 600 the new vehicle for baking enamels, completely eliminates five hazards. Gives the enamel exceptionally good flow & leveling.
12-13a *American Cyanamid Co.

Mineral Insulated Cable.....Brochure lists many and varied uses for industry. Contains section on hazardous area use and on mineral insulation for instrumentation.
186A General Cable Corp.

Nitrogen Analyzer.....6-page bulletin includes product data and application information on automatic analyzer that can proform micro-Dumas process in 15 minutes.
186B Coleman Instruments, Inc.

Phosphate Plasticizers.....provide rapid solvation with most resins, assure permanence, are resistant to extraction by oils & water. Information available.
71 *Celanese Chem. Co.

Plastic.....Seilon offers a complete line of corrosion resistant thermoplastic sheet materials . . . available in stock sheets 4' x 8' from $\frac{1}{16}$" through 1" in thickness.
176 *Seiberling Rubber Co.

Plastics Catalog.....Revised and updated 64-page catalog contains information on plastics in sheet, rod, tube and film forms. Material referenced for easy ordering.
186C Commercial Plastics & Supply

Plastics Catalog.....36-page catalog contains mechanical and electrical properties of products listed; illustrates and describes in detail basic shapes available.
186D Raybestos-Manhattan, Inc.

Polyethylene Film.....2-page technical data sheet lists problems, causes and corrective measures in heat sealing film. Service for problems not covered is also offered.
186E U.S. Industrial Chem. Co.

Polymer Catalog.....12-page directory and catalog lists properties, end uses, per cent solids, viscosity, pH, particle size, specific gravity etc. for 150 polymers.
186F Borden Chemical Co.

Protective Coatings.....Resistance properties and typical uses for cold-applied coal-tar coatings detailed in booklet. Coatings are primarily moisture barriers.
186g Allied Chemical Corp.

Resin Adhesives.....Technical bulletin includes many new uses of synthetic resin adhesives ranging from shoe manufacturing to auto production and building construction.
186H Monsanto Chemical Co.

Silicone Applications.....Summary of forms, properties and applications contained in 16 page booklet. Products reviewed range from adhesives to water repellents.
186I Dow Corning Corp.

Sodium Benzoate.....Flake-form sodium benzoate is available in two grades: U.S.P. grade & Technical grade. You can get either form in powder form, too. Tech. data.
93d *Hooker Chemical Corp.

*From advertisement, this issue

Synthetic Lubricant.....Technical bulletin describes high temperature lubricant that manufacturer claims has established new standard of stability, lubricity, and cleanliness.
187A Heyden Newport Corp.

Surface Active Chemicals.....Bulletin describes applications and tabulates properties of 37 nonionic surface active chemicals. Company equipped to tailor-make products.
187B Hodag Chemical Corp.

Surfactants.....Brochure lists complete line of Emcol surface active agents classified by use and by chemical type. Uses are classified under 10 headings.
187C Witco Chemical Co.

Sulfur Monochloride.....is a good chlorinating agent & it is relatively easy to handle. It contains 52.0 to 52.5% chlorine. Data Sheet available.
93a *Hooker Chemical Corp.

Construction Materials

Alloy.....Full discussions of the physical & metallurgical properties of Ni-o-nel and of its resistance to numerous corrosives is contained in Tech. Bul. T-37.
40 *The International Nickel Co.

Alloys.....for problems from high temp. oxidation, carburization or from corrosion due to nitriding gases or chemicals in flue gases. "Hastelloy Alloy X" booklet.
151 *Haynes Stellite Co.

Aluminum Conductors.....100-page publication lists immediately available sag and tension charts for covered and bare conductors. Useful for purchasing and utility engineering.
187D Aluminum Co. of America

Cable.....Safety MI Cable for hazardous applications and for remote control & instrumentation. Catalog outlines characteristics of this cable.
177 *General Cable Corp.

Castings.....The latest catalog is now available. Castings that can be used in equipment to meet high temperature (anything up to 2300 F) and/or corrosion.
32 *The Duraloy Co.

Ceramic Catalyst Carriers.....are described in detail in the Bulletin, "Keys to Better Catalysis" which is now available on request.
135 *Norton Company Refractories Div.

Corrosion Protection.....12-page brochure describes rubber and plastic linings and coverings for tank and processing equipment protection. Includes diagrams and illustrations.
187E Amer. Hard Rubber Co.

Fabrication.....Equipped for special fabrication to suit your process requirements exactly. Process equipment such as ducts, stacks, hoods, etc. Facts in Bul. 101.
190 *du Verre Inc.

Filter Media.....Bulletin A180 the natural and man-made filter media. Includes anode bags and diaphragms, centrifugal liners, dust tubes, etc.
173 *American Machine & Metals, Inc.

*From advertisement, this issue

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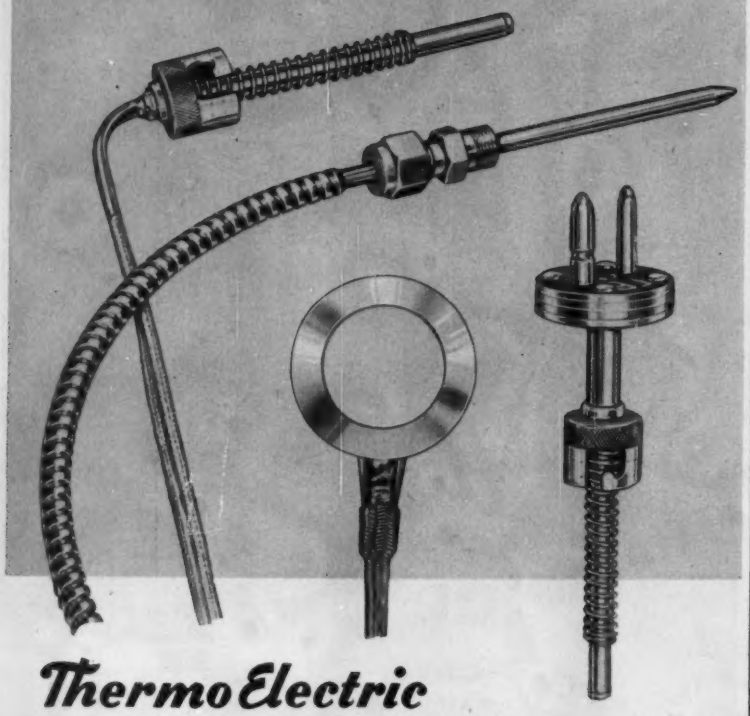

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LITERATURE . . .

Insulating Materials.....Catalog describes complete line of over 30 industrial insulations with properties and specifications ranging from sub-zero to 1,900F.
188A Baldwin-Ehret-Hill, Inc.

Lead Products.....These products include chemical lead sheets to your requirements; pipe, bends, traps and standard fittings. Lead Handbook Bulletin No. 162.
89 *American Smelting & Refining

Plastic.....Ryertex-Omicron PVC licks more than 280 corrosive liquids & gases. Chemically inert, PVC imparts no odors, or tastes. Nonsparking & nonmagnetic. Facts.
102b *J. T. Ryerson & Son, Inc.

Rubber & Plastic Tank Linings.....for alkalies, acids, bleaches, salts. Faultless seams, indestructible bond, shock & age-resistant. Bul. CE-53.
167b *American Hard Rubber Co.

Seals.....in a wide range of sizes & lip designs including Split Clipper Seals for temporary replacement in compounds that will resist every heat, speed or corrosive condition.
179 *Johns-Manville

Seals.....Design and data handbook gives test information on 150 fluids and gases that may be used with o-rings. Includes o-ring and groove design techniques.
188B Parker Seal Co.

Stainless.....There are 2351 kinds & sizes of sheets, plates, bars, tubing, pipe & fittings in stock. Facts about this anti-corrosive material on request.
102a *J. T. Ryerson & Son, Inc.

Tower Packings.....Porcelain tower packings resist high temperatures, fumes, vapors corrosion, liquids, alkalies and acids. Information, prices & samples on request.
BL195 *Knox Porcelain Corp.

Wire Cloth.....from any metal or alloy including titanium. In nine basic weaves from finest to coarsest mesh. A 94-page catalog is offered on request.
26 *The Cambridge Wire Cloth Co.

Wire Cloth.....for filtering, sizing, straining, testing. Hundreds of meshes, weaves and metals to fit your specific need. Information in Bulletin FC.
169 *Newark Wire Cloth Co.

Electrical & Mechanical

Dry Fluid Drives.....Flexidyne is available, off the shelf, in Drives & Couplings. Capacities range from fractional to 1,000 hp. Technical bulletin.
174 Dodge Mfg. Corp.

Mechanical Seals.....Type U seal for service at temperatures of from 100 below zero to +650 F, and for pressures from 0 to 100 psi. Engineering information offered.
168 *Borg-Warner

Motors.....Super-Seal motors, with Silco-Flex insulation feature advancements such as capsule bearings, split end housings, and integrated field coils.
67 *Allis-Chalmers

*From advertisement, this issue

Motors.....designed for all your requirements large or small, for plant or product. Standard motors or special motors built to fit your needs.
90 *Wagner Electric Corp.

Motors & Generators.....A copy of the data and specification file on Electric Motors and Generators is now available for your ready reference on request.
35 *Marathon Electric Mfg. Corp.

Safety Head.....relieves undesirable pressure build-ups instantly, rapidly reducing pressure within a system to a safe zone of operation. Information on request.
162 *Black, Sivalls & Bryson, Inc.

Speed Reducers.....with new worm hardness pattern which gives maximum thread strength and resistance to wear. Latest developments in Bulletin No. 405.
137 *Cleveland Worm Gear

Torqometers.....in a wide range of sizes, plus torque drivers for proper tensioning of screws. These are widely used in electronic & electrical assembly.
182 Snap-On Tools Corp.

Turbines.....YR turbines offer dependable operation under all conditions of heat, cold, moisture, dust and contaminated atmosphere. Complete details.
147 *Elliott Co.

Turbines, High-Speed.....in sizes up to 6000 hp. Complete information about Terry multistage turbines is contained in Bulletin S-146 which is offered.
143 *Terry Steam Turbine Co.

Handling & Packaging

Belt Conveyor Idlers.....48-page engineering and product information booklet includes details of construction, selection, procedure and examples, engineering tables, etc.
189A Hewitt-Robins, Inc.

Belt Weigher.....Pneu-Weigh offers extremely high accuracies, wide ranges, capacities in compact, uncomplicated unit. Bulletin 36.20-1 for details.
158 *B-I-F Industries, Inc.

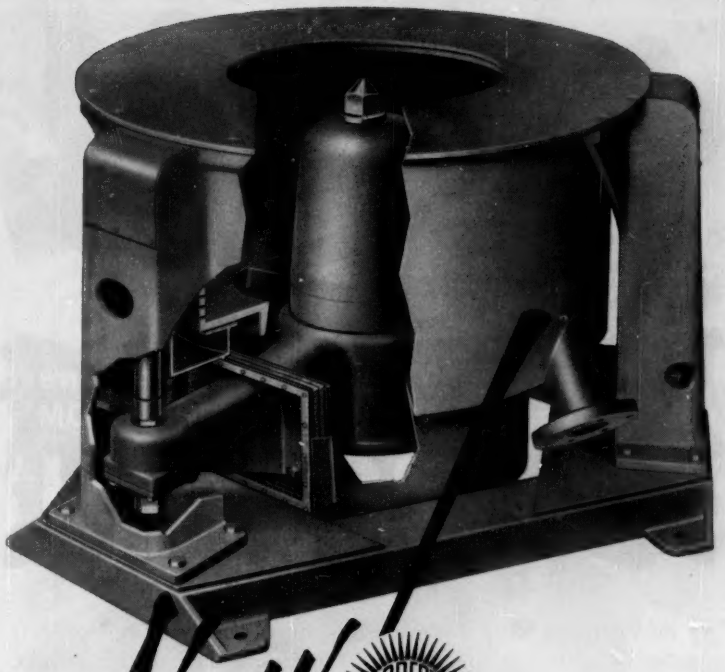
Feeders.....Amplitrol Feeders can control discharge rates from any distance. Feed the major portion of a batch at torrent rates, the remainder at a dribble. Information.
156 *Carrier Conveyor Div., Chain Belt

Fork Lift Truck Equipment.....Accessories and optional equipment for fork lift trucks are described in bulletin. Includes lighting equipment, snow plow, etc.
189B Allis-Chalmers

Packaging.....Capcote PE bags give you polyethylene protection. Five grades available according to the moisture resistance you need. Literautre available.
14-15 *St. Regis Paper Co.

Payloader.....features full power-shift transmission, power-steering (turning radius of only 6 ft.) and power-transfer differential. Data on request.
49 *The Frank G. Hough Co.

*From advertisement, this issue



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Heating & Cooling

Cryogenic Electronics.....Leaflet describes variety of miniature and compact refrigeration systems for cooling electronic devices to temp. ranging from 3.5k to 200k.
190A Air Products Inc.

Heat Transfer.....The new Multi-Zone Platecoil introduces a new principle of coil design. Solves tough tank & process heating problems. Data in Bul. P61.
99 *Tranter Mfg. Co.

Heat Transfer Cement.....Thermon can be applied over both steam tracing & electrical resistance systems & is effective for heating & cooling operations. Bul. 300.
R165 *Thermon Mfg. Co.

Heaters.....Catalog 60 on general industrial heating applications. More than 15,000 different types, sizes & ratings of electric heaters & heating elements.
34 *Edwin L. Wiegand Co.

Miniature Thermocouples.....are available in a wide variety of sizes, standard thermocouple materials, adapt to many applications. Bulletin 1256-4.
188 *Thermo Electric Co., Inc.

Panelcoil.....New heavy gauge embossed Panelcoil available in 5 widths from 12" to 29", in lengths up to 143". Data Sheet 15-60 Series & Price Bul. 259 offered.
BR198 *Dean Products, Inc.

Steam Traps.....A 48-pg. book tells how to correctly size, install & maintain steam traps for any pressure, temperature or any load. Also Catalog K for data.
45 *Armstrong Machine Works

Instruments & Controls

Data Processing System.....Bulletin describes system containing pinboard programming, analog-to-digital conversion, transistorized electronics and application flexibility.
190B Beckman Instruments Inc.

Flowmeter.....This new rotameter-transmitter transmits electrically or pneumatically. The Design Specification Sheet DS-361 is available on request.
R164 *Brooks Rotameter Co.

Gauges.....Complete information about the Maxitest or the complete line of Ashcroft test gauges and gauge testers is contained in Catalog 300 B.
73 *Manning, Maxwell & Moore, Inc.

Gauges.....A complete catalogue on high pressure gauges for use in refineries and chemical plants. Information on Gauge Cock, Heated or Cooled Gauges, etc.
L164 *Strahman Valves, Inc.

Instrumentation.....The design and process engineer's guide to industrial temperature measurement and control thru Mercury-Bulb instrumentation is available.
190C The Partlow Corp.

*From advertisement, this issue

Instruments.....Metagraphic instruments are ideal for graphic panel use or where true "plug-in" versatility is necessary. Complete information on request.
48 *The Bristol Co.

Meter.....Tne Type 316 stainless steel meter for measuring liquid fertilizer & corrosive chemical solutions. Accuracy ±.5% (20-100 GPM). Descriptive Literature.
TL195 *Badger Meter Mfg. Co.

Meter.....Auto-stop meter shuts off automatically at the exact amount. Helpful meter data contained in bulletin 566YY which is now being offered.
185 *Neptune Meter Co.

Recorder.....Transcope plug-in provides a complete cascade system. Gives continuous 30 day record. The unique set point transmitter allows continuous control. Catalog
10-11 *Taylor Instrument Co.

Recorder-Controller.....unit continuously & simultaneously records 4 variables on the same chart. Clear, easy-to-read records for continual analysis & control.
48 *Bailey Meter Co.

Tank Meter.....for measuring tank contents any distance away. Also gauges for barometric pressure, absolute pressure, pressure & vacuum, etc. Bulletins.
TR198 *Uehling Instrument Co.

Temperature Controls.....for accurate dependable service within the 70 to 1100 degree range. Electric, mechanical, pneumatic, indicating, among types available.
38-39 *The Partlow Corp.

Pipe, Fittings, Valves

Bearings and Bushings.....90-page study includes extensive collection of case histories, engineering and test data on sleeve bearings and bushings of aluminum.
191A Aluminum Co. of America

Fittings.....Catalog covers Cosasco Access Fitting principle, High-Pressure Retrievers & the line of instruments for corrosion surveys without system shutdown.
191B Grant Oil Tool Co.

Fittings.....Braze-Seal tube fittings withstand super-pressures, high temperatures . . . retains make-and-break convenience. New Hi-Seal Catalog covers fittings.
141 *The Imperial Brass Mfg. Co.

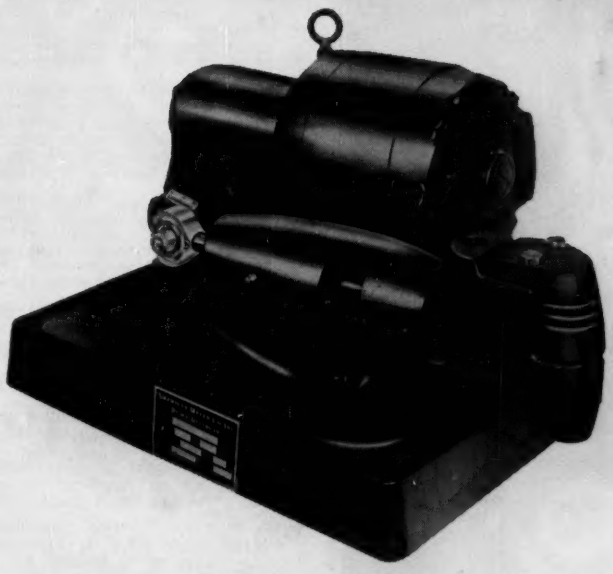
Fittings.....Wall or desk chart designed to simplify selection and application of steel and brass fittings. Covers complete range of flared, flareless and pipe fittings.
191C The Weatherhead Co.

Flexible Hose.....Detailed information to aid in selection, performance and installation given in bulletin describing hoses used in fume control, dust collection etc.
191D The Flexaust Co.

Pipe.....High impact rubber-plastic, most economical for average chemicals. Screw or solvent welded fittings. Valves ½ to 2". Send for Bulletin 80A.
167a *American Hard Rubber Co.

* From advertisement, this issue

American 200 Series Chemical Feed Pumps



• METERING ACCURACY OF ±1%

• CAPACITY TO 1624 GPH.

New 200 Series Simplex model can pump up to 812 gph. Duplex model has double this capacity. Maximum pressure of 10,000 psi.

Easy, inexpensive operation is assured by these quality features:

- Self-contained lubrication system—no downtime for lubrication.
- E-Z Clean Cartridge Valves simplify maintenance.
- Interchangeable liquid ends for greatest adaptability in the field.
- Precision screw adjustment on crank for easy accurate stroke regulation.
- Sealed Self-aligning bearings on crank and crosshead withstand greater radial and axial thrust loads.
- Crossheads of hardened and ground steel ride on cast iron.
- Heavy duty reducers.
- NEMA frame motors.

Precision built 200 Series pumps handle a wide variety of "tough," corrosive materials. In Chemical Processing, Refining and Boiler Feed operations, the pumps assure highest accuracy in feeding precisely metered fluids in virtually all ratios, with flow, temperature, pressure, conductivity, PH and other controlled process variables.

Write today for more information.

AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1836
pump division
13500 PHILMONT AVE. PHILADELPHIA 16, PA.

DOES YOUR MIXING EQUIPMENT MEET THESE STANDARDS ?

- Ease in maintenance through simplicity of design
- Durability because of stellite-faced stator and rotor
- Precision control affording correct clearances down to the smallest particle size
- Maximum shearing surfaces of rotor and stator achieve highest dispersion rate in minimum time

PREMIER

. . . and only PREMIER OFFERS ALL THESE FEATURES . . . RESULTING IN . . . INCREASED PRODUCTION . . . LOWER COSTS!

Send Premier for complete engineering service on any mixing problem

PREMIER MILL CORP.
224 C Fifth Ave., New York 1, N.Y.

LITERATURE . . .

Pipe, PVC.....The 36-page Technical Handbook on PVC Pipe is packed with information, including flow charts & corrosion resistanee chart covering 160 acids.
207 *Kraloy Plastic Pipe Co., Inc.

Tube Expanders.....New tube expanders roll tubes into thick sheets in one pass. Bul. Y-52 outlines the complete line of retubing accessories plus tube expanders.
159 *Elliott Co.

Tube & Pipe.....Fibercast offers many advantages if you have corrosion, temperature or pressure problems. Specific information about Fibercast plus a free sample.
24-25 *Fibercast Co.

Tubing.....Full information on Job-Matched Seamless Pressure Tubing is contained in Bulletin TB-417. Wide size range & uniform sizes & mechanical properties.
46 *The Babcock & Wilcox Co.

Tubing.....12-page bulletin, designed for easy selection of tubing for any given application, summarizes significant properties of 84 tubing analyses in seven groups.
192A Superior Tube Co.

Tubing, Plastic.....Tygon plastic Tubing offers an outstanding range of corrosion resistance. Easy to clean. Sixty-five sizes to 4" O.D. Tech. data in Bul. T-97.
50 *U. S. Stoneware

Tubing, Welded Steel.....is uniformly round, dependably sound, readily shaped & assembled. Data-filled Bul. 8591 & immediate information on your current needs.
29 *Formed Steel Tube Institute

Valve, Ball.....The Econ-O-Miser is available from ¼" through 6" size range & is ideally suited to difficult media because of its smooth round flow.
69 *Worcester Valve Co., Inc.

Valve, Check.....The Basic-Check Unit will handle almost any liquid, gas or air over a broad range of temperature-pressure ratings. Bulletin CE-50.
160 *Durabla Mfg. Co.

Valves, Butterfly.....Operates from simple lever to automatic & remote control. No limit in size. Construction of any metal. Details in Bul. 590X.
R195 *W. S. Rockwell Co.

Valves, Safety Relief.....are available in both Standard and Balanced Bellows design for extreme corrosive applications. Complete details in Bul. 1940.
30 *Manning, Maxwell & Moore, Inc.

Valves, Solenoid.....Conduit type and grommet type. Port sizes ⅛" and ¼ NPT. Ten orifice sizes: 3/64" through ½". Pressures to 540 psi. New bulletin.
TL197 *Marsh Instrument Co.

Valves, Fittings, Unions.....Stainless and alloy steel materials are shown in their application to specific types of piping products in the 432-page Catalog F-10.
133 *Henry Vogt Machine Co.

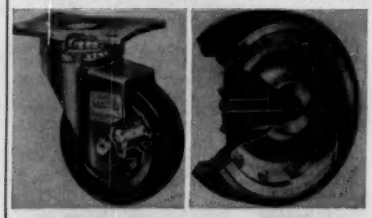
Valves & Fittings.....have high burst strength. All parts made of plastic. Newest literature on the complete line of PVC Valves & Fittings is now available.
88 *Walworth

* From advertisement, this issue

RUGGEDLY BUILT FOR YOUR TOUGHEST JOBS!

DARNELL
CASTERS AND WHEELS

Built to take it... Indefinitely!



designed to suit your every need

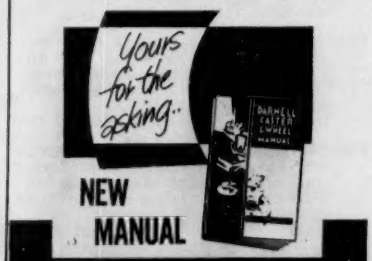
RUBBER TREADS . . . a wide choice of treads suited to all types of floors, including Darnelloprene oil, water and chemical-resistant treads, make Darnell Casters and Wheels highly adapted to rough usage.

RUST-PROOFED . . . by zinc plating, Darnell Casters give longer, care-free life wherever water, steam and corroding chemicals are freely used.

LUBRICATION . . . all swivel and wheel bearings are factory packed with a high quality grease that "stands up" under attack by heat and water. Quick grease-gun lubrication provides easy maintenance.

STRING GUARDS . . . Even though string and ravelings may wind around the hub, these string guards insure easy rolling at all times.

Write today for the complete story

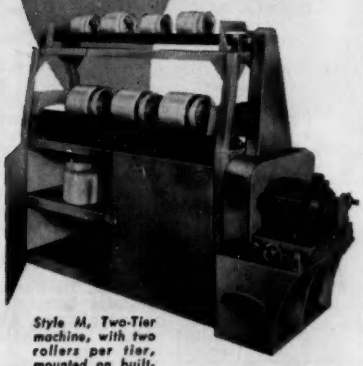


DARNELL CORPORATION, LTD.
DOWNEY (LOS ANGELES COUNTY) CALIFORNIA
37-28 SIXTY FIRST ST. WOODSIDE 77, L. I., N. Y.
36 NORTH CLINTON STREET, CHICAGO 6, ILLINOIS

MULTIPLE BATCH GRINDING WITH VERSATILE

abbé

JAR ROLLING MACHINES



Style M, Two-Tier machine, with two rollers per tier, mounted on built-in storage cabinet.

Multiple batches of similar or different materials can be economically ground, pulverized or mixed simultaneously on a versatile Abbé Jar Rolling Machine.

Jars, bottles or containers of different sizes can be used at one time. Each jar can be removed after its full grinding or mixing cycle has been completed—without stopping the machine.

Modern, rugged Abbé Jar Rolling Machines are available to handle single or parallel rows of jars, and in double or triple tiers for processing as many jars as required. Standard porcelain or steel jars range in size from 1 quart to 6 gallons. Built-in storage cabinets on tiered machines are optional.

Write for NEW Abbé Jar Rolling Machine Catalog 79

abbe ENGINEERING CO.

620F GRAYBAR BLDG., NEW YORK 17, N. Y.

Designers and Manufacturers of Ball, Pebble and Jar Mills • Pulverizers Sifters • Cutters • Mixers

LITERATURE . . .

Process Equipment

Blenders, Rotary.....available in nine standard models with capacities to 900 cu. ft. Feature self-cleaning, dust-sealed drum. Information on Blenders in Bul. 080B.
R197 *Sturtevant Mill Co.

Centrifugal.....The link suspended, stationary curb centrifugal machine features direct coupled hydraulic motor and oversize anti-friction bearings.
189 *The Western States Machine Co.

Centrifugals.....Batch-O-Matic can be constructed of stainless steel, "Hastelloy", titanium or other alloys. Corrosion-resistant coatings may be specified. Bul.
170 *American Machine & Metals, Inc.

Crystallizers.....Krystal Crystallizers feature uniformly sized, dust-free crystals, product purity, ease of centrifuging or drying, etc. Descriptive bulletin.
33 *Struthers Wells Corp.

Dryer.....The atmospheric double drum dryer Model 2-28-60 has several special features for drying a chemical compound. Catalog "A".
T209 *Davenport Machine & Foundry Co.

Dryer, Vacuum Chamber.....Phenolic resin-lined double door chamber dryer designed to process heat-sensitive chemicals. Cat. 201 describes all Drying equipment.
75 *J. P. Devine Mfg. Co.

Dryers.....Data Sheets are available which describe typical humidity control installations. They'll serve as guides in planning your own systems.
157 *Pittsburgh Lectrodryer Div.

Dryers, Desiccant.....features complete reactivation, perfect temperature control and full automatic operation. Further details contained Bulletin D-103.
81 *The C. M. Kemp Mfg. Co.

Evaporators.....for all chemicals . . . acids, salts, pharmaceuticals, recovery of industrial waste. Details on the complete Buflovak evaporator line in Catalog 372.
196 *Blaw-Knox

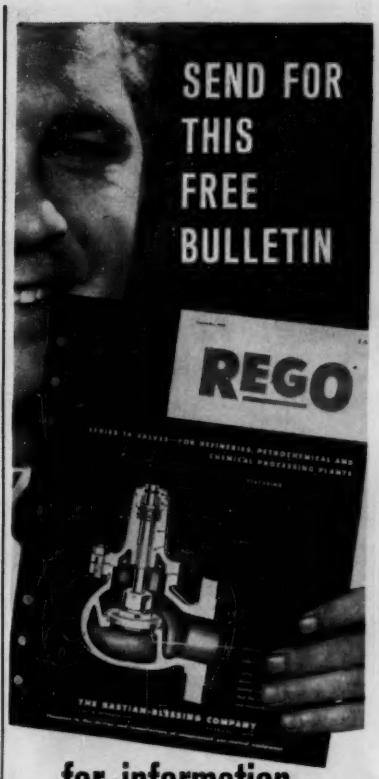
Filter.....The Rotary Drum Vacuum Filter offers high washing efficiency and fume tight construction. Complete pilot-scale test facilities are offered.
2 *Bird Machine Co.

Filter.....The Eimco-Burwell is equipped with an electric timing control circuit & all auxiliaries for automatic operation on a multi-cycle basis. Bul. F-2052.
Cover *The Eimco Corp.

Filters.....Operating with process streams from 5 to over 1,000 gal. per minute, Niagara filters can be adapted to automatically process hundreds of materials. Bul.
171 *American Machine & Metals, Inc.

Filters.....with automatic sluicing to handle any filter cake, even the thin, slimy ones. Informative Bulletin EF/2a is now available on request.
145 *The Duriron Co., Inc.

* From advertisement, this issue



for information on improved valve performance

Features application and specification details for outstanding TA Series Globe and Angle Valves. Permanently leakproof – no packing to adjust or cause binding of stems: have exclusive Teflon V-Ring Pressure Seal, providing positive leakproof stem seal; Teflon Seat Disc for long life. Rugged Ductile Iron body. Bulletin lists over 100 different fluids that can be controlled by TA Series Valves.

REGO®

Pioneers in the design and manufacture of compressed Gas Control Equipment

FREE LITERATURE

Write Department 22-E
The Bastian-Blessing Company
4201 Peterson Avenue
Chicago 46, Illinois

- ☐ TA Series Globe and Angle Valves
- ☐ Relief Valve Manifolds
- ☐ Liquid Oxygen Relief Valves
- ☐ High Pressure Gas Regulators
- ☐ High Pressure Cylinder Manifolds

A new shaft seal to handle the most corrosive service conditions has been recently added to the John Crane line. Here's a seal that will stand up under all conditions of acids and salts, oxidizing agents and organic compounds.

It is so designed that all parts that normally contact the fluid are made of chemically-inert DuPont Teflon. Also, for this same reason it can be operated over wide temperature range up to 250° F.

Mechanically, its bellows type construction readily adapts it for use in all non-abrasive slurry applications. It also compensates for extreme shaft run out.

Available in single face construction for internal or external mounting, double face for internal mounting.

Full range of shaft sizes from ⅜" to 3".

Get Complete Details

Request Bulletin S-233
Crane Packing Company
6451 Oakton Street
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(Chicago Suburb)
In Canada:
Crane Packing Company, Ltd.
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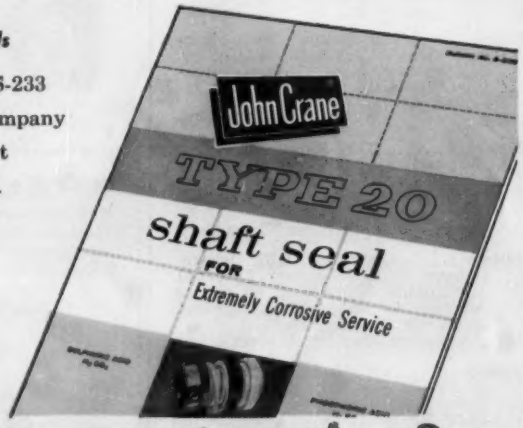


CRANE PACKING COMPANY

LITERATURE . . .

Filters.....All filters are characterized by high filtrate-clarity, rapid cleaning, high flow rates, and low filter cycles. Technical bulletins on request.
L198 *Hercules Filter Corp.

Filters.....Bulletin describes complete line of stainless-steel filters and filter elements. Methods of specifying filter area needs are given with flow rates and porosity.
194A Micro Metallic Div.

Filters, Continuous Vacuum & Pressure.....Standard sizes range from 5 to 800 sq. ft. of filtering area. Additional information in bulletins that are offered.
172 *American Machine & Metals, Inc.

Filters, Wire Cloth.....4-page booklet covers typical fluids and systems that can use wire cloth filters. Includes details of design features, construction and performance.
194B Bendix Filter Div.

Grinding Mills.....for many materials, capacities and finenesses. A complete line to fit your plant, process & product. Capacities from a few lbs. up to 40 tons per hour.
100a *Combustion Eng., Raymond Div.

Jar Rolling Machine.....are available to handle single or parallel rows of jars, & in double or triple tiers for processing as many jars as required. Catalog 79.
L193 *Abbe Engineering Co.

Mixer.....New model RL Hi-Shear Head offers finer, faster blending, dispersing & homogenizing. All parts stainless steel. Controllable flow pattern. Information.
184 *Gabb Special Products Inc.

Process Equipment.....Votator processing equipment is used for continuous polymerization reactions in numerous installations. Votator pilot systems available.
161 *Girdler Process Equip. Div.

Process Equipment.....Glass-lined equipment for the chemical processing industry. Progressive reactors, Vessels, and Agitators in all shapes & sizes. Data offered.
22-23 *A. O. Smith Corp.

Process Equipment.....Bulletins giving complete information on rotary kilns, primary & secondary gyratory crushers, jaw crushers, apron feeders, ball mills offered.
16 *Traylor Engineering & Mfg.

Reaction Vessels.....manufactured in cast iron and fabricated steel, stainless steel, alloys, and clad to ASME codes.
L165 *Bethlehem Foundry & Machine Co.

Reversible Impactor.....CDL Series Impactors offer easy accessibility, identical reduction, balanced wear, etc. Full description in Bulletin.
47 *Bath Iron Works, Penn. Crusher Div.

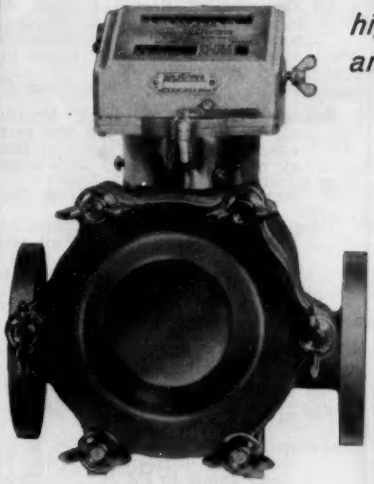
Ribbon Blender.....Nine different size units ranging from 16 to 300 cubic feet working capacity are available in stainless steel or carbon steel.
85 *The Strong Scott Mfg. Co.

Screens.....Applications and specifications for pierced metal and slit screens recently introduced in the U. S. are described in 12-page bulletin No. C101.
194C Cross Perforated Metals

* From advertisement, this issue

Badger's 2" stainless steel meter with magnetic drive...

high accuracy on chemical and fertilizer applications



- Ruggedly constructed of Type 316 stainless steel for measuring liquid fertilizer and corrosive chemical solutions.
- Key maintenance features: simple design, take apart construction for easy, quick cleaning. Magnetic drive eliminates packing gland.
- Accuracy ±.5% (20-100 GPM), operating pressure to 150 PSI, and temperatures to 150° F.
- Order with low-cost standard totalizer, combined gallon totalizer and reset totalizer or electric batch. Can be equipped with remote reading Read-o-Matic register as accessory.
- *Typical uses:* measuring, blending, batching of liquid corrosive chemicals and fertilizers in manufacturing and bulk plant operations.

Badger Meter Mfg. Co.
Industrial Products Division
4545 W. Brown Deer Rd. • Milwaukee 23, Wis.

Write for descriptive literature

VALUE ENGINEERING PROVES

ROCKWELL *Resilient-Seated* Butterfly Valves *STAND OUT*

- Weigh Less—Cost Less
- Need Less Space
- Easier to Install
- Always Operable
- Low Pressure Drop
- No Fouling
- Negligible Maintenance
- Simplified Control —Manual or Remote

Bodies lined with any elastomer—from natural rubber to Viton.
Construction of any metal.
Operates from simple lever to automatic and remote control. No limit in size.
Let Bulletin 590X help you put value engineering to work on your valve applications. Just mail the coupon below.

W. S. ROCKWELL COMPANY
2300 Eliot St., Fairfield, Conn.

Send me Bulletin 590X.

Name .....
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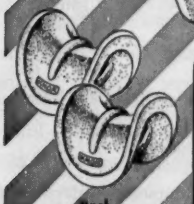
KNOX

DIRECT FROM MANUFACTURER To YOU!



Tower Packings

KNOX produces porcelain tower packings from the same composition as is used for high voltage electric porcelains.

Resists high temperatures, fumes, vapors, corrosion, liquids, alkalies and acids.

Non-porous — complete vitrification firing 2300°F. provides zero porosity, thus assuring an indefinite life chemically.

Uniform quality—high chemical purity—iron-free—great mechanical strength—will not crumble.

If you're interested in Better Tower Packings at lower Operating Cost, we'll be glad to send more information, prices and samples on request.

IRON FREE

Always Specify KNOX Tower Packings

KNOX PORCELAIN CORPORATION
KNOXVILLE 1, TENNESSEE

BUFLOVAK EVAPORATORS

for all chemicals . . .

acids, salts, pharmaceuticals, recovery of industrial waste . . .

Whatever your material in process may be, Buflovak Equipment will provide the way to the most profitable operation. The right evaporator, selected from a complete range of designs, can be job-tailored for your product. ■ The Buflovak evaporator line includes: Natural and Forced Circulation, Downflow, Agitated Film Roto-Vak, Crystallizers, Calandrias, Single and Multiple Effects. ■ For details, write for Catalog 372, Buflovak Equipment Division, 1551 Fillmore Avenue, Buffalo 11, New York.

Buflovak Equipment Division

BLAW-KNOX

LITERATURE . . .

Pumps, Fans, Compressors

Air Compressors.....Bulletin describes balanced/opposed compressors for standard 110 psi industrial applications. Capacities range upward from 375 cfm.
196A Clark Bros. Co.

Blowers.....“Blue Ribbon” Ventilator-Blowers are portable and easily adaptable . . . for supplying fresh air or discharging foul air or fumes. Additional facts on request.
B209 *Coppus Engineering Corp.

Compressors.....4-page folder describes rotary screw type air compressors that deliver from 6,900 to 19,400 cfm at 110 psi. Includes information on design features.
196B Atlas Copco

Gas Absorber.....washers are extremely efficient air pollution control units capable of collecting acid mists & inert particulate material. Bulletin AP-125 for details.
21 *Buffalo Forge Co.

Pump.....The 3715 handles a wide range of corrosive liquids. Ten sizes. Temp. to 350 F, capacities to 720 GPM, heads to 280 feet. Bulletin 725.4 is offered.
28 *Goulds Pumps, Inc.

Pump.....The K-288 pump units are suitable for many different pumping problems. Capacities range from 17 to 164 G.P.M. Maximum pressure 200 P.S.I.
BL197 *Viking Pump Co.

Pumps.....Bulletin No. S-111 covers the 4, 5, and 6 series APCO turbine type pumps. Single or two stage. Capacities to 150 GPM, pressures to 300 PSI.
79a *N. Y. Air Brake, Aurora Pump Div.

Pumps.....The 3 Series with capacities to 12 GPM, heads to 50 feet are covered in Bulletin U-111-A. Single stage . . . packed stuffing box . . . flexible coupling drive.
79b *N. Y. Air Brake, Aurora Pump Div.

Pumps.....Bulletin U-111-B describes the 32 Series which offer capacities to 10 GPM, heads to 250 feet. Feature lubricated-for-life bearings.
79c *N. Y. Air Brake, Aurora Pump Div.

Pumps.....Type V31 self priming pumps are single stage close coupled. Capacities to 15 GPM, heads to 350 feet. Additional information in Bulletin V-111-A.
79d *N. Y. Air Brake, Aurora Pump Div.

Pumps.....Complete information on Type V4 contained in Bulletin V-111-B. Capacities to 30 GPM . . . heads to 350 feet . . . mechanical seal.
79e *N. Y. Air Brake, Aurora Pump Div.

Pumps.....Type Z4 Chemical Process pumps available in single stage or two stage. Capacities to 50 GPM, pressures to 400 PSI. Bulletin Z-111-A.
79f *N. Y. Air Brake, Aurora Pump Div.

Pumps.....Bulletin 111XJ covers Type X40. Water jacketed packed stuffing boxes or mechanical seals. Capacities to 60 GPM, heads to 350 feet.
79g *N. Y. Air Brake, Aurora Pump Div.

*From advertisement, this issue

New...from MARSH!

Conduit-type Master-mite. Grommet-type also available.

Small Solenoid Valves that fill a BIG Order

Designed to meet the need for positive-acting tight-seating valves for use on wide variety of media, including oxygen, hydrogen, acetylene, etc.

Two Types:
Conduit type and grommet type. Port sizes 1/8" and 1/4" NPT.

Ten orifice sizes: 3/64" through 1/4".

Wide range of voltages:
Standard with 115 V. A. C. but also available in 12, 24, 208, 230, 460 V. A. C.

Pressure to 540 psi.
Small, but with more strength in the Marsh manner. Coils never overheat. Entire assembly leak tight. Remarkably quiet operation. Cleanable without breaking connections. Used in any position. Bodies either brass bar stock or 18-8 stainless steel. All moving parts stainless. Underwriters' approved for use on oxygen and hydrogen and as safety valves.

Write for new bulletin

MARSH INSTRUMENT COMPANY
Dept. 24, Skokie, Illinois
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.

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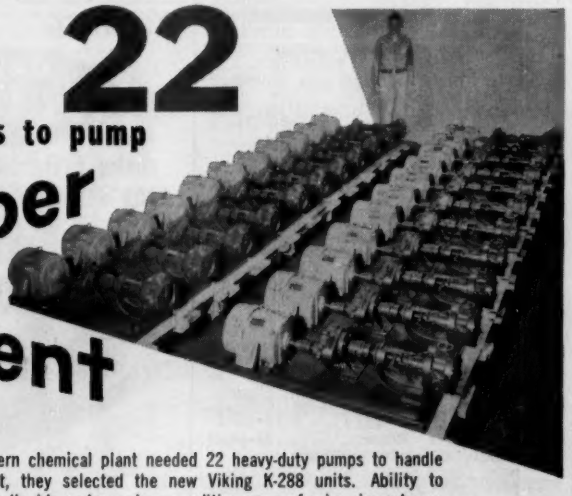
22 Vikings to pump Rubber Cement



When an eastern chemical plant needed 22 heavy-duty pumps to handle rubber cement, they selected the new Viking K-288 units. Ability to handle viscous liquids under various conditions was of prime importance. Other major considerations were: quiet operation, cleanliness and simplicity in servicing. Compact, pressed steel bases also cut space and weight.

These K-288 pump units are suitable for many different pumping problems. Their five gear reducers are interchangeable and permit speeds ranging from 280 to 520 R.P.M. using 1750 R.P.M. motors, and 190 to 420 R.P.M. using 1200 R.P.M. motors. Capacities range from 17 to 164 G.P.M. Maximum pressure 200 P.S.I.

Check these pumps for your next pumping job. Ask for catalog sec. cc pages 27-28.

VIKING PUMP COMPANY
Cedar Falls, Iowa, U.S.A.
In Canada, it's "ROTO-KING" Pumps
World Wide Sales and Service
See our Unit in Chemical Engineering Catalog

Highly Intimate Blends in 1 to 2 Minutes

Blends while discharging; No segregation or flotation

Sturtevant Rotary Blenders start 4-way blending while charging, continue it during discharge, thus producing highly intimate, even blends of dry and semi-dry materials – within 3 to 5 minutes of start of charging.

Six *complete* blending cycles per hour are common. And Sturtevant's special action produces no particle reduction, cleavage or attritional heat – is highly effective yet gentle and safe even with explosives.

Receiving
Scoops cascade material as drum rotates. Movement forces material from both ends to middle. Thus blending is 4-way right from start of charging.

Discharging
Single gate controls charge, discharge. Blending continues throughout discharge phase. Result is no segregation or flotation — highly intimate, even blends.

Self-cleaning, dust-sealed drum; one-man accessibility

Operation of Sturtevant Blenders is self-cleaning – drum interiors are completely dust-sealed. For inspection of all models, one man simply loosens a few lugs to remove manhole cover – quickly and easily.

Nine standard models with capacities to 900 cu. ft.

10 cu. ft. Sturtevant Blender at U.S. Steel Corp.'s new Applied Research Laboratory (Raw Materials Division) in Monroeville, Pa. This unit handles batches up to 500 lbs. — is ideal for pilot work and small runs.

One of four 450 cu. ft. Sturtevant Blenders at Celriver Plant of Celanese Corp. (Rock Hill, N. C.). These large units handle up to 20,000 lbs. batches — have a 9-year record of meeting the most exacting blending requirements.

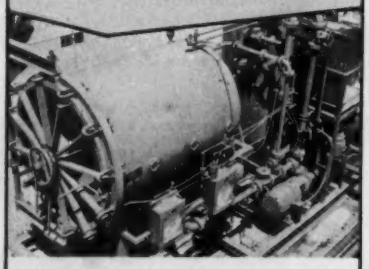
Fully or semi-automatic, or manually controlled operation

Constructed of carbon steel, stainless steel or Monel metal, Sturtevant Rotary Blenders are engineered to fit each customer's needs – can be supplied with injector sprays and any desired control system.

For more on Sturtevant Blenders, request Bulletin No. 080B. (Bulletins also available on Mixers, Air Separators, Micronizers, Crushers and Grinders.) Write today. STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

Hercules Filters!

FOR HIGH CLARITY AND RAPID CLEANING



"ROTO-JET"
"RAPIDOR"
"D.C.D"
(DRY CAKE DISCHARGE)
"VAC-U-FLO"

All Hercules Filters are characterized by high filtrate-clarity, rapid cleaning, high flow rates, and low filter cycles.

Hercules Filters may be used with any type of filter medium: fibres or diatomaceous or other earths; pre-coated on metallic or synthetic screens or cloths.

The leaves are cleaned by sluice down, vibration or cake cut off—all within the filter—followed by screw conveyor ejection.

For further details write for illustrated catalog.

HERCULES FILTER CORP.
208 ETHYL AVENUE
HAWTHORNE, NEW JERSEY

MAIL THIS COUPON TODAY

HERCULES FILTER CORP.
Hawthorne, New Jersey
Please send technical bulletins regarding your filters for:
NAME.....
COMPANY.....
ADDRESS.....

LITERATURE . . .

Pumps.....Bul. 234 describes Stock Pumps for pulp and paper mills. The composite dimension sheet showing SOD Type with standard suction nozzles is included.
198A Warren Pumps, Inc.

Pumps, Centrifugal.....Catalog contains photos & performance characteristic charts for the Centrifugal Fuel Transfer Pump & Centrifugal Cryogenic Transfer Pump.
198B The J. C. Carter Co.

Pumps, Chemical Feed.....New 200 Series Simplex model can pump up to 812 gph. Duplex model has double this capacity. Maximum pressure of 10,000 psi. Information.
190 *American Meter Co.

Pumps, Submersible.....Heavy duty, high capacity pumps used for both deep well and in-line boosters are described in bulletin. Capacity range to 3300 gallons per minute.
198C Sumo Pumps, Inc.

Services & Miscellaneous

Casters & Wheels.....designed to suit your every need. New Manual contains the complete story about the outstanding features such as rubber treads and string guards.
R192 *Darnell Corporation, Ltd.

Circular Slide Rule.....Pocket size calculator may be used to multiply, divide and find proportions. Persons not qualifying as engineers or executives will be charged 50c.
198D General Industrial Co.

Conversion Tables.....48-page pocket-size reference book for converting U. S. and British units into metric system. Covers temperature, volume weight and pressure.
198E European Technical Coverage

Engineering.....Information on complete low-temp. service from process engineering of complete plants & custom-designed equip. to tech. consultation.
186 *American Air Liquids

Engineering & Building.....To learn more about Kellogg's background in engineering & building olefin plants, at home & overseas, request the current Kelloggram.
63 *The M. W. Kellogg Co.

Fire Hose.....The D-500 is available with white, black, yellow or red cover for ready visibility. Full story of this newest advance in fire-fighting equipment on request.
87 *Goodyear, Industrial Products

Fused Quartz Ware.....32-page catalog describes products made of pure fused quartz and silica. Complete specifications on laboratory and industrial ware are given.
198F Thermal American Fused Quartz

Fire Safeguards.....28-page catalog describes fire-fighting eqiupment with information on sprinkler, CO^2, smoke detection, dry chemicals, and foam systems.
198G The Fyr-Fyter Co.

Water Purification Equipment..... for Pure Water in either laboratory amounts or production quantities. New pure water literature is available on request.
166 *Barnstead Still & Sterilizer Co.

*From advertisement, this issue

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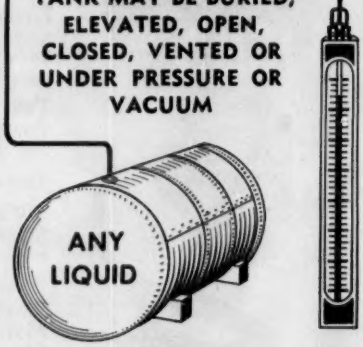
FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY

TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM



Also gauges for:
Barometric Pressure (Mercury Column)
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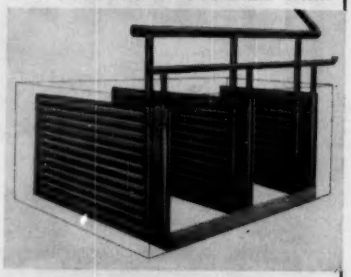
DEAN PANELCOIL

FORMS PARTITIONED HEATING UNIT FOR SEMI-LIQUID STORAGE TANK



Dean Panelcoil, because of its greater structural strength, is ideal for building into equipment as part of the shell, bottom, top, or, as shown above, as tank partitions.

In addition, Dean Panelcoil is more economical and efficient than old style pipe coil and conventional jacketing. It generally costs less to install. It takes less room, weighs less and gives fast, even heating or cooling.

Write for Data Sheet 15-60 Series and Price Bulletin 259.

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STerling 9-5400
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Permanent employment with an expanding company. Excellent advancement opportunities for men with at least 10 years experience in process design of petroleum and petro-chemical plants.

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New division of multiple plant manufacturers plastics, resin and rubber products and adhesives, offers unusual opportunity to young man with supervisory experience or potential.
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Due to expansion an opening for a Chemist in our Technical Control Division is available immediately. Excellent growth opportunities exist for qualified man with one or two years laboratory experience.

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Chemical Engineer—With experience in production of inorganic chemicals required for South American position, Spanish required. P-4182, Chemical Engineering.

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Chemical Engineer, Surface treatment, Electro Plating. Metal finishing now in Israel wishes to change position to U. S. or Canada. P. O. Box 902 Ramatgan, Israel.

Chemical Engineer desires position as process or instrument engineer. BS 1953 from MIT Experience 2 years in chemical processes 3 years as instrument sales engineer. PW-4175, Chemical Engineering.

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PRODUCTION MANAGER

Experienced Assistant or Production Manager to manage production activities. Knowledge in any of the following areas of silicones, compounding, extrusion and molding or combination of these areas desirable. Individual will have complete independence in managing plant production activities and a major role in top management decisions.

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Experienced Chemist or Chemical Engineer with strong background in rubber chemistry and environmental testing to direct new laboratory. Individual will have complete freedom to establish this new research activity and guide its future growth. A Ph.D. in rubber chemistry or chemical engineering or comparable experience desired. Position calls for contact with major chemical companies.

These positions offering rare opportunities for individual growth, advancement, financial gain, are offered by a young, highly progressive rubber company, located in a pleasant suburban area of Eastern Maryland, which has doubled its sales every 2 years during their 10 year operation; offering retirement, profit-sharing, insurance, health benefits—plus a congenial and cooperative management staff.

SALARIES OPEN. Write stating experience, qualifications, salaries earned. Replies held confidential.

P-4132, Chemical Engineering
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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With a minimum of five years experience in plastics polymerization and extrusion. For design and start up of new facilities, trouble-shooting, process improvement, cost and efficiency studies.

Excellent opportunity for advancement in a dynamic and expanding medium sized organization.

Foster Grant Co., Inc.

Leominster, Mass.

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Well known Manufacturer of Heavy Duty Crushing and Grinding Machinery has opening for experienced man. Salary and commission, welfare and retirement plan. Midwest location. Give full details of past experience in first letter. Replies confidential.

P-3954, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

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Here's your opportunity to enjoy life in a pleasant community . . . enjoy working in a stimulating environment. Our community is a progressive, medium size southwestern city. An ideal place to raise a family and enjoy the good things of life.

You will work with mathematicians and scientists on challenging problems utilizing the services of a high speed digital computer of the largest size. Responsibilities will include analyzing and correlating physical and thermodynamic properties of gases and liquids. BS, MS or PhD essential.

Job assignment and salary appropriate to your field of interest, qualifications, and potential for achievement. Many plus benefits, such as insurance, thrift and retirement plans.

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Chemical Engineering's Professional Service Section offers the quickest, most direct method of contracting consultants who may be available NOW.

CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

CE's Searchlight spots the big bargains in used, resale and rental equipment. Check this issue's listings—most complete in the field—for items you need now

▶ **Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date**—May 30th issue closes May 6th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

WANTED

Product Lines for Capital Goods Equipment Serving the Processing Industry.

We are a manufacturer of equipment serving the process industry, and have excess capacity. We maintain a very substantial sales organization with sales upwards of $5,000,000. We have open capacity and would like to purchase a proprietary line with a minimum sales volume of $250,000, per year. Write

BO-4153, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

CIRCLE A ON READER SERVICE CARD

ECH SPECIAL

Abbe Eng. Jacketed 5' x 6' Ball Mill, chrome manganese steel. Price $2750.00.

EQUIPMENT CLEARING HOUSE, INC.
111 33 Street Brooklyn 32, N. Y.
SOuth 8-4431—4452—8782

CIRCLE B ON READER SERVICE CARD

ANSWER

to Worthington "Hidden Value" Puzzle on Inside Back Cover

The fictitious "hidden value" is *Adjustable Roller Main Bearings*. The design of any balance opposed compressor makes roller bearings impractical from a maintenance standpoint. Worthington balanced opposed compressors use centrifugally cast sleeve bearings which can be removed for inspection or maintenance without disturbing the crankshaft or removing the connecting rod from the frame.

DIESEL LOCOMOTIVES & CRANES
3—New 25 Ton, 2 GE I Whitcomb.
3—23 Ton, 2-45 Ton Used Gen. Elec.
1—44 Ton, 1-80 Ton Used Gen. Elec.
3—100 Ton, Gen. Motors, Used.
1—25 Ton, Industrial 60' Boom Loco. Crane.

PLANT EQUIPMENT
2—Wemco 2M-HMS-Plants.
36 x 42 Jeffrey Hammermill, Type B-2.
No. 5060 Dixie Mogul Hammermill 500 H.P.
2—6' x 36' Hardinge Ball Mills.
2—5' x 8' Kennedy Van-Saun air swept Ball Tube Mills with Motors & Elec. Eye.
7' x 24' Allis-Chalmers Tube Mill.
5' x 10' & 7' x 15' Rod Mills.
14 x 28 New England Jaw Crusher.
30" x 36" Traylor Type H Jaw Crusher.
48" x 72" Buchanan Type "C" Jaw Crusher.
56" x 72" Traylor Style G Jaw Crusher.
No. 1 Sturtevant Rotary Fine Reduction.
2' Symons Standard Cone Crusher.
207-10 Type 316 SS LB Roto Louver Dryer
36" x 20' Ruggles Coles Class XF-1 Rotary Dryer.
2 207-10 & 2705—24 Link Belt Roto Louver Dryers.
Link-Belt Mono-Tube 24-10 Dryers.
54" x 35' Louisville Monel Steam Tube Dryer.
72" x 28' Madison Rotary Dryer.
5' x 30' Ruggles Coles Class XA-8 Rotary Dryer.
8' x 60' Rotary Dryer, ½" Welded Shell in Calif.
9' x 160' Vulcan Rotary Kiln.
42" x 18" Traylor Type AA Crushing Rolls.
5'-6" x 60' Rotary Dryer or Cooler.
F55 Syntron Grizley Feeder.
24" x 95' NEW Hewitt Robins Truss Belt Conveyor.

R. C. STANHOPE, INC.
60 E. 42nd St. N. Y. 17, N. Y.
Tel. MU 2-3075

CIRCLE D ON READER SERVICE CARD

PIPE

2,000,000 ft.	2"	3.50# to the foot
1,000,000 ft.	3"	7.70#
1,000,000 ft.	4"	10.98#
500,000 ft.	6"	19.80#
200,000 ft.	8⅝"	28#
400,000 ft.	10¾"	35#
75,000 ft.	12¾"	40#
10,000 ft.	16"	42#

All No. 1 Grade Plain End and Cleaned
INDIANA-OHIO PIPE CO.
P.O. Box 5412 Shepard Sta. Phone CL 3-5527
COLUMBUS 19, OHIO

CIRCLE E ON READER SERVICE CARD

FOR IMPOSSIBLE BUDGETS

ROTARY STAINLESS DRYER
Allis-Chalmers 6' x 50' Rotary Stainless Steel Lined Dryer. ½" shell. 20 HP Motor & Drive
Excellent Condition
Wire or phone collect—GA 1-1380
ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

CIRCLE F ON READER SERVICE CARD

LIQUIDATION

TITANIUM DIOXIDE PLANT
BALTIMORE, MD.

CENT.—FILTERS—EVAPS.—CRYSTAL

1—Bird 32" x 50" Cont. Cent. 316 S.S.
4—Sharples C20 Super D-Hydrators, 316 S.S.
1—AT&M 26" sus. Cent., perf. bskt., 316 S.S.
1—Oliver 8' x 8' Precoat rubber covered Rotary Vacuum Filter.
4—Sperry 36" plate & frame Filters, cast iron, and wood.
5—8' dia. x 24' rubber lined Crystallizers.

PULVERIZERS AND MILLS

2—Abbe 5' x 16' brick lined Mills.
2—30" dia. Stainless Steel Micronizers complete with Hoppers, Conveyors, etc.

ROTARY KILNS

1—Traylor 11' x 155' Rotary Kiln, 7/8" shell.
1—Renn. 6' x 60' Rotary Kiln, 5/8" shell.

RUBBER LINED TANKS

5—8500 gal Vertical Storage 8'6" x 16' x 8' cone.
1—13,000 gal. Horizontal Storage 8' x 35'.

STEEL TANKS

6—2000 to 5200 gal. with Turbo Agitators.
14—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gals.

MISCELLANEOUS

7—Dorr Thickeners: 16' dia. with Tanks.
1—Bemis 50# Bag Packer with Sewing Machine, Conveyor and Flattener.
50—LaBour, Durco, Worthite, Duriron and Stainless Steel Centrifugal Pumps 2" to 6" with motors.

Representatives on premises,
2701 Broening Highway, Baltimore, Md.
Telephone: Medford 3-2911

BRILL EQUIPMENT CO.
35-65 Jabez Street,
Newark 5, N. J.
Tel: Market 3-7420

CIRCLE G ON READER SERVICE CARD

LIQUIDATION

CEMENT PLANT
AKRON, N. Y.

2—Allis Chalmers 8' x 100' Rotary Kilns.
1—Raymond 36" Bowl Mill, 50 HP.
1—Vulcan 6' x 50' Dryer, 25 HP.
1—Clyde #3 Hydrator with motor.
1—Raymond 16' double whizzer Separator, 75 HP.
14—Bucket Elevators, chain mounted, steel casing, 25' to 56' c.c.
1200'—9" and 14" Screw Conveyor.
15—Bins from 6' x 7'6" x 12' to 17' x 20' x 12'.
1—Steel Building, 60' x 80' x 40' high.
1—Steel Building, 65' x 125' x 40' high.

LIST AVAILABLE ON REQUEST
REPRESENTATIVE ON PREMISES

BRILL EQUIPMENT CO.
35-65 Jabez Street
Newark 5, N. J.
Tel: Market 3-7420

CIRCLE H ON READER SERVICE CARD

BUY BRILL

SPECIALS

1—Williams 5 Roll High Side Mill, 8' dia. Separator, fan, piping, etc.
1—4000 gal. 316 S.S. clad agitated Reactor with coils.
2—Pfaudler 1000 gal. glass lined, jacketed, agitated Reactors.
1—Louisville 6' x 45', 316 S.S. Rotary Steam Tube Dryer.
2—Buflovak 42" x 120", atmospheric double drum Dryers, complete.
1—Sperry 18" x 18" Filter Press, 316 S.S., P & F, 15 chambers.

CENTRIFUGES

2—Baker Perkins 36 HS TerMeer, continuous.
1—Sharples C-27 Super-D-Hydrator, 316 S.S.
1—Bird 18" x 28", 316 S.S. Solid Bowl, Continuous.
1—Bird 36" x 50", 347 S.S. Solid Bowl, Continuous.
2—Sharples PY14, PN14, Super-D-Canters, 316 S.S.
1—Tolhurst 32" Suspended, 316 S.S., imperforate basket.
2—AT&M 48" Suspended, 316 S.S. basket.
2—Sharples #16, 304 S.S., 3 HP motor.

REACTORS—EVAPS—CONDS—TANKS

1—Condenser Service 650 gal. 304 S.S. closed Kettle, 5' x 4', with 100 sq. ft. bayonet heater.
1—1400 gal. Blaw-Knox, steel, jacketed, agitated Reactor.
1—2000 gal. Struthers Wells 316 S.S., jacketed, agtd. Reactor.
2—3200 gal. 316 & 347 S.S., jacketed, agitated Kettles.
1—550 sq. ft. Buflovak monel single effect Evaporator.
1—7500 gal. 316 S.S. Vert. Storage Tank, 7' x 25', 50 psi.
1—750 gal. nickel clad Mixing Tank, 125# nickel coils.
1—4000 gal. Haveg Vert. Tank 8' x 12'.
1—1500 gal. Stainless Pressure Tank, 5' x 10', 90#.
1—12,000 gal. horiz. steel Pressure Tank, 7'6" x 36', 200 psi.
6—Stainless Heat Exchangers: 1220, 786, 536, 370, 315, 250 sq. ft.
1—24" dia. x 35', 304 S.S. Bubble Cap Column.

FILTERS

1—Oliver 6' dia. Horizontal Filter, 216 S.S.
1—Oliver 3' x 6' Steel Rotary Vacuum Precoat Filter.
1—Oliver 5'3" x 6' Rotary Vacuum Precoat Filter, 316 S.S.
1—Niagara #370-38 Filter, 370 sq. ft., 304 S.S.
2—#49 Valles Rotating Pressure Filters, 738 sq. ft.
1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaportite housing.
1—Feinc 5' x 6' Stainless Steel Rotary Vacuum Filter.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft

DRYERS

1—Buflovak Vacuum Shelf with 20—60" x 80" shelves.
1—Devine Vacuum Shelf with 19—59" x 78" shelves.
1—Devine Vacuum Shelf with 10—40" x 43" shelves.
2—Devine 4' x 9', single drum, atmospheric.
1—Buflovak 3' x 10' Rotary Vacuum Dryer.
1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
2—Louisville Rotary Steam Tube 6' x 25', 6' x 50'.
9—Rotary Dryers, 34" x 30', 4' x 40', 6' x 50', 6' x 60', 7' x 80', 8' x 87'.
2—Louisville 8' x 50' Stainless steel lined Rotary Dryers.
1—Traylor 30" x 18' Stainless steel Rotary Dryer.
2—Link Belt, 7'5" x 25", 6'4" x 24', S.S. Louvre Dryers.

MIXERS

1—Baker Perkins 100 gal., jacketed, double arm, 30 HP.
1—Baker Perkins #16TRM, 150 gal. jktd., Vac. 60 HP.
1—Baker Perkins 50 gal. jacketed, double arm.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
2—Steel jacketed Powder Mixers, 225 and 350 cu. ft.
1—3' dia. Ximpson Intensive Mixer.

MISCELLANEOUS

1—#3TH Mikro Pulverizer, 15 HP.
1—Raymond 10' dia. Single Whizzer Separator.
1—#5 Mikro Atomizer with motor and cyclone.
2—Bantam Mikro Pulverizers, S.S.
1—Ross 6" x 14" Three Roll Mill.
3—Swenson Walker Continuous Crystallizers, 24" x 30' sections.
2—Robinson Sifters, 40" x 84", Stainless.
1—#24 Rotex Sifter, 20" x 64", Quadruple deck.
8—Stokes; DD2, DDS-2, T, "R", and "F" Tablet Presses.
4—Nash Vacuum Pumps; H6, T57, #2.
25—Chlorimet, Durimet and Duriron Centrifugal Pumps, 1½" to 6".

PARTIAL LIST OF VALUES **SEND FOR COMPLETE CIRCULAR**

BRILL EQUIPMENT COMPANY
35-65 JABEZ STREET **NEWARK 5, N. J.**
Tel.: Market 3-7420 • Cable: Bristen
TEXAS OFFICE—4101 San Jacinto St., Houston 4, Texas—Tel.: Jackson 6-1351

CIRCLE J ON READER SERVICE CARD

FMC

S-T-R-E-T-C-H

A TIGHT BUDGET WITH ECONOMICAL FMC EQUIPMENT

OUTSTANDING SELECTIONS

J. H. Day 40 Gal. Pony Mixers
J. H. Day Hi Speed 3 Roll Mills
J. H. Day 200 Gal. Paragon Mixers
Stainless Heat Exchangers to 1000 sq. ft.
S/S Patterson-Twin Shell Blenders; 30 cu. ft. & 150 cu. ft.
S/S Patterson-Kelly Twin Blenders; 30 cu. ft. and 150 cu. ft.
Pfaudler Glass Lined Jacketed Thimble Condenser
10—Stainless Heavy Duty Vertical 850 Gal. Tanks with Agitators

REACTORS and PRESSURE VESSELS

Mojonnier S/S Vac. Pans; 3' x 10'; 6' x 12'
Nickel Clad Reactor; 7' x 11'6"; Jkt. Agt.
Struthers Wells Type 316 S/S; 1000-2000 Gal.
Pfaudler Gl-Lnd; Jktd. Agtd. to 1000 Gals.
Lancaster S/S Lined Rotary Jacketed Reactor; 50" Dia x 17'14" long
Three Stage Continuous Agitated Reactor, 3 Vessels 4'x20' in tandem
Dopp 650 Gal. C.I. Jktd. Agtd. Reactor
250 Gal. Hi-Pressure Forged Steel reactor, Jacketed and Agitated; 48" x 72"

DRYERS and EVAPORATORS

Stokes Rotary Jktd. Dryer; 18' x 18'
Stainless Lined Rotary Dryer; 50" x 20"
B & S Dbl. Drum Dryer; 28" x 60"
Buflovak(Dbl. Drum Dryer; 40" x 120"
Zaremba INCONEL Dbl. Effect Evaporator
Swenson Multi Effect Long Tube, Film Type Evaporators

FILTERS and FILTER PRESSES

Shriver and Sperry Filter Presses to 42 in Cast Iron, Stainless, Ni-Resist, Aluminum
Oliver Continuous Rotary Panel Type Vacuum Filters; 8' x 8' and 8' x 10'
Feino String Type Rotary Vacuum Filters 6' x 6' & 8' x 10'; Stainless contacts
Bird Young Rotary Vacuum Filter, 4' x 4'
Sweetland Pressure Filters No. 2 to 12
Enzinger Vertical Stainless Pressure Filter; 18" x 26"; ASME; 24 sq. ft.
Stainless Nutsche Type Filter 6' Dia. x 2'
Bowser Filter with Pump; 2000 GPH; 69 sq. ft.
Enzinger Leaf Type Filter, 48" x 57" Tank with 15 leaves; 360 sq. ft. surface

PLASTIC and RUBBER EQUIPMENT

F-B Late Style 2 Roll Rubber Mills, 14" x 30"; 16" x 42"; 18" x 42"; 22" x 60"
Three Roll Calender; 22" x 58" complete
Baker Perkins Hv. Duty Mixers to 300 Gal.
Banbury Type "B" Laboratory Mixer
Two Adamson Vulcanizers; 16' long
Abbe Pebble Mills with Motors, Pebbles; 37" x 48"; 45" x 48"; 60" x 72"; 8' x 8'
Truck Dryer; 11' x 15' x 30"; 7' x 12' x 100'
Automatic Mechanical Dryer; 100' long
Automatic Washer for Late Pads
Southwark Hydraulic Presses; 36" x 36"
Dunning & Boschert Hydraulic Presses 36" x 36"
French Oil Mill Presses; 28" x 30"
Stokes Aut. Molding Press No. 252; 300 Ton
Extruders: Royle No. 1; Allen No. 2; NRM 1½"
Kux, Stokes & Colton Tablet Presses

MILLS—GRINDERS—PULVERIZERS

Abbe Jacketed Steel Ball Mills, 42" x 36" with charge of balls
International Porcelain Lined, Ball Mill 8' x 8'; 50 HP Motor
Patterson Jacketed Ball Mill, 54" x 42"; good for Vacuum
Mikro Pulverizers; up to No. 4's
Fitzpatrick Comminuting Mills, Stainless Steel; Models C, D, K
Mikro S/S Atomizers Model 5 & 6
Williams Hammer Mills to 16" x 48"
Williams Ring Roll Lab Mills, 3 Roll, 10" x 3"; complete
Raymond Imp Mills; many models
American Ring Roll Crusher with 30" x 33" Throat; 50 HP Motor

CENTRIFUGES and EXTRACTORS

Bird Continuous Conical Horizontal Centrifuges; 8"; 24"; S/S Monel
Sharples H2 Nozzlejector; 15 HP
Sharples Monel Model M4 P Centrifuge
DeLaval Type 316 S/S Hermetic Separator
Fletcher 12" and 30" S/S Centrifugals
Rubber Covered Centrifugals; all sizes

Send for "FIRST FACTS" containing complete LISTINGS

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209-289 TENTH ST.
BROOKLYN 13, N. Y.
STerling 8-4672

CIRCLE K ON READER SERVICE CARD

CHEMICAL EQUIPMENT DIVISION

Raymond 3 Roll #3036 Hi-Side Mill
Buflovak 19 Shelf Vacuum Shelf Dryers
1000 sq. ft. Stainless Heat Exchangers (2)
Fletcher 30" Susp. S.S. 10/5 H.P. Centrif.
Tolhurst 40" S.S. Center Slung Centrif.
Fletcher 40" Susp. Steel Centrifugal
Sweetland #12, #10, #7 Filter Presses
30 Gal. S.S. Jktd. Autoclave 1000 PSI Int.
Shriver 30"x30" P&F 36 C.I. Chambers
Nooter 750 gal. Steel Reactor 300 PSI
Link Belt 502-16 Roto-Louvre Dryer
8'x80' Rotary Dryer 316 S.S.
Vulcan 9'x100' Rotary Kiln
Mosser 4'x47' Rotary Dryers
Louisville 6'x50'; 6'x25' Steam Tube Dryer
F. J. Stokes 38A & 382A Tray Dryers
Stainless Tanks 100, 200, 350 gal.
Condensers 100 to 5000 sq. ft. Steel; Admir.
Pressure Vessels 300 to 4500 gal.
J. H. Day 600# S.S. Jktd. Powder Mixer
Dixie #5060 Mogul Hammermill 500 HP
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Readco 25 gallon SS vac D.A. mixer
Rotex 40" x 84", 40" x 120" double deck sifters
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400 gallon SS agit reactor

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Concentrating Table: Deister #14, 5' x 8'.
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Dryers: Devine 2 x 4' vac. drum, st. steel.
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Homogenizers: 25, 50, 80, 125 GPH.
Homogenizers-Dispenser: Tri-Homo #10, #4
Kettles: st. steel, with and without ag.
Dopp 150 gal. dbl. act. agitator.
Mills: Mikro, 1SH, 5 hp.
Day 3-roll high speed 14x30"
Mikro Atomizer type 5MA st. steel.
Colloid, 3, 5, 20, 25 hp.
Mixers: Dbl. and sgl. arms sigma blade.
Dry Powder, various sizes.
W. & P. size 14, 50 gal. jktd.
Mix-Muller: Simpson Porto 39" st. steel.
Pumps: Rotary, gear, centrif. vacuum.
Screen: Rotex model 41 st. steel.
Still: Double effect st. st. 11.83 gal.
Tablet Press: Stokes DD2, 23 station.
Truck Tanks: Stain. steel 1200, 1600 gal.
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2—Hardinge 7' x 36" conical pebble mills, silex lined

19—Abbe Eng. 6' x 8' pebble mills, 30 HP drives

2—Buchanan 13" x 24" jaw crushers, 50 HP

2—Symons 3' shorthead cone crushers, fine bowl, 50 HP

1—Christie 4'-6" x 45' long rotary spar dryer, complete

1—Allis-Chalmers 6' x 18' pebble mill, buhrstone lined

SEND FOR CIRCULAR

TANKS—VESSELS

3—18,000 gal., vert., alum., 12' x 31', cone bottom.
1—17,650 gal., horiz., T316 SS, 9' x 36', ¼" shell, ⅜" dished heads, 40# WP.
1—5800 gal., vert., alum., 10' x 10', agit.
10—4500 gal., vert., Nickel-clad, 8' x 11', 125# WP.
1—3700 gal., vert., T304 SS, 6' x 17', VACUUM, int coils.
1—3400 gal., horiz., T304 SS, 6'6" x 16', ¼" shell, 7/16" dished heads.
1—3300 gal., vert., T304 SS, 6' x 14'6", ⅜" shell, ⅜" heads, 70# WP.
1—2830 gal., horiz., T316 SS, 6' x 12', 5/16" shell & dished heads, VACUUM.
3—2750 gal., vert., T316 SS, 7' x 8', dished heads, 50# WP, 75 sq. ft. coil.
4—2600 gal., vert., T316 SS, 7' x 8', flat bottom, 19# WP, 5 HP agit.
1—2500 gal., vert., T316 SS, 7' x 7', ¼" shell, 5/16" dished heads, 70# WP.
5—2250 gal., vert., T316 SS, 7' x 6'3", dished heads, 70# WP, 5 HP agit.
1—2100 gal., vert., T316 SS, 6' x 9'10" open top, cone bottom.
1—2100 gal., vert., alum., 6' x 10', dished heads.
1—1900 gal., vert., T316 SS, 6' x 8', ⅜" shell & dished heads, VAC. or 100#.
12—1750 gal., vert., hoppers, T304 SS, double cone bottom.
2—1200 gal., vert., T316 SS, 5' x 7', cone bottom, VACUUM.
1—575 gal., vert., T316 SS, 4' x 6', 3/16" shell, ¼" dished heads, 35 sq. ft. coil.
100—Tanks & vessels, 100 to 1000 gal., all types, etc.

BUBBLE-CAP COLUMNS T316 STAINLESS STEEL

1—110" dia. Vulcan—10 trays
2—96" dia. Vulcan—30 trays
1—96" dia. Vulcan—10 trays
1—60" dia. Vulcan—10 trays
1—48" dia. Vulcan—25 trays—T304 ELC
1—42" dia. Vulcan—Packed—32' high
1—36" dia. Vulcan—6 trays
1—24" dia.—Packed—28' high, T304

HEAT EXCHANGERS—CONDENSERS

1—2000 sq. ft., T316 SS condenser
1—1960 sq. ft., T316 SS exchanger, ASME
8—800 sq. ft., T316 SS condensers
60—T316 SS condensers & exchangers, 1450, 800, 735, 427, 400, 300, 264, 250, 235, 200, 165, 150, 125, 110, 47, 30
25—Copper & Cupro-nickel exchangers & condensers, up to 1070 sq. ft.

FILTERS—CENTRIFUGALS

1—Niagara #510-28, 510 sq. ft. vert. leaf, T316 SS.
1—Alco 110 sq. ft., T316 vert. filter.
1—Elmco 18" dia. x 24" face T304 SS rotary vacuum.
2—Oliver 5'3" dia. x 3' face rot. vac., pressure precoat, T316 SS, ASME 30# pressure housing.
1—Oliver 5'3" dia. x 8' face rot. vac., precoat, steel. UNUSED.
8—Sharples #AS-16V super cent. Inconel, Vapor-tite.
2—Sharples #16P, T304 SS pressure-tite centrifugals.
3—Sharples #C-20 Super-D-Hydrators, T316 SS.
2—Bird 18" x 28" horiz. cent., T304 SS.
1—Bird 32" x 50" horiz. cent., T316 SS.
2—Sperry 30" P. & F. filter presses, 19-9 st. st. (NI-RESIST).

BEST BUYS

3—10' dia. x 78' long rotary dryers, ¾" shell, 4' dia. center heat tube.
1—Kennedy Van Saun 7' x 9' contin. ball mill—150 HP.
1—Struthers-Wells 630 sq. ft. T316 SS evaporator.
3—18,000 gal. Aluminum cone-bottom tanks, 12' dia. x 31' OAH.
1—Link-Belt #604-18 roto-louvre dryer, cyclone, fan, etc.
3—Worthington 160 ton steam-jet vacuum refrig. units.
2—Buffalo T316 SS Blowers, 2330 cfm, 60 HP TEFC. Motor.
2—1800 cu. ft. Read T304 SS weigh hoppers, with scales, T304 SS screw conveyor, bucket elevators, AJAX "Le-veyor" shaker conveyors.
1—Vulcan 10' x 11' x 175' long rotary kiln, 13/16" shell, 2 tire.
1—Bartlett & Snow 3' x 15' overdur rotary dryer.

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AUTOCLAVES, KETTLES AND REACTORS

1—Type 316 SS 2000 gal. horizontal tank
2—Lee stainless steel 1000 gal. storage tanks
1—Pfaudler SS 5 gal. jacketed reactor, complete with impeller type agitator drive, 100 psi internal, 78 psi jacket
1—Van Alst 250 gal. SS jacketed kettle complete with SS column and condenser
2—300 gal. SS jacketed kettles, 100# W.P. jacket
3—Struthers Wells type 316 SS jacketed reactors, 2000 gal., complete with agitators and drives, 40# internal pressure
2—Pfaudler 200 gal. glass lined jacketed, reactors, complete with anchor type agitators and drives
1—Pfaudler 100 gal. glass lined jacketed reactor, complete with anchor type agitator and drive
1—Pfaudler 100 gal. glass lined vacuum receiver
2—Blaw Knox SS 600 gal. vacuum receivers, 29" Hg
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Struthers Wells type 347 SS pressure vessel 300 gal., complete with agitator and drive
1—Blaw Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—18,000 gal. type 316 SS pressure tank, 11' x 24', 60 psi
1—Blaw Knox 45 gal. jacketed autoclave, 1500# pressure
1—Patterson Kelley 6000 gal. steel jacketed kettle
2—Steel jacketed reactors 2500 gal.
1—18,000 gal. aluminum storage tank
5—Aluminum storage tanks, 1300 gal. each

DRYERS

3—Link Belt steel roto louvre dryers, Model 207-10, 310-16, 604-20
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
2—Louisville rotary dryer, 8' x 50', SS
1—Buflovak SS jacketed rotary vacuum dryer, 3' x 15'
1—Stokes SS jacketed rotary vacuum dryer, 2' x 6'
3—Buflovak steel jacketed rotary dryers, 3' x 15', 5' x 20' and 5' x 35'
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer 6' x 36'
2—Stokes Model 138J-20 single door vacuum shelf dryers, 20 shelves, complete
1—Western Precipitation Corp. SS pilot spray dryer, Type N-2

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
12—Sweetland #12 Filters with 72 SS leaves
1—Niagara SS filter, Model 510-28
1—Oliver SS rotary pressure precoat filter, 5'3" x 8'
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" x 42"
1—Shriver aluminum 30" x 30" P&F filter press, 30 chambers
1—Sperry aluminum filter press, 18" x 18" P&F 16 chambers

CENTRIFUGES

1—AT&M 48" SS suspended type centrifuge, complete with plow, motor and imperforated basket
1—Fletcher 48" center slung SS centrifuge complete with perforated basket and motor

THE GELB GIRL—MAY 1960

4—Tolhurst 40" center slung rubber covered centrifuges with perforated baskets and motors
2—Fletcher 40" center slung rubber covered centrifuges with perforated baskets and motors
1—AT&M 40" SS suspended type centrifuge, complete with motor and plow with perforated baskets and motors
1—Western States vaportite type 316 SS under driven centrifuge with 36" perforate basket, with unloader and motor, bottom discharge

MIXERS

15—Robinson type 304 SS horizontal blenders, 255 cu. ft.
1—Howes horizontal rubber covered ribbon blender, 40 cu. ft.
2—Sturtevant #7 dustite rotary batch blenders, (NEW)
1—Baker Perkins Size 16 Type TRM, 150 gal. jacketed double arm sigma blade mixer with vacuum cover
1—Baker Perkins Size 20, 2000 gal. double arm jacketed vacuum mixers with double naben blades
1—Entoleter impact mill type PPM-27
1—Stokes SS granulating mixer, Model 211
3—Banbury #1 mixers, chrome plated rotors, with 50 HP motors
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MISCELLANEOUS

1—York Shipley 175 HP package steam generator, 135# psi
1—Vulcan SS bubble cap column, 4' x 28 plates
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq. ft.
10—Davis Engineering SS heat exchangers, 145 sq. ft. (NEW)
4—Davis Engineering Corp. 20 heat exchangers, 120 sq. ft. each (NEW)
1—Downington type 316 SS heat exchanger, 750 sq. ft.
2—Swenson type 316 SS vacuum crystallizers, 3'6" x 12', 2' x 12'
3—Williams type 316 SS Hammermills, Model AK
1—Sprout Waldron Model 501-D pelleter
1—Ross 6" x 14", 3 roll paint mill, complete
1—Sweco 48" SS separators, Model D-2D-8
1—Stokes stainless steel coating pan, 3' dia.
50—Steel heat exchangers, 15 sq. ft. to 100 sq. ft.

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75 ANNIVERSARY

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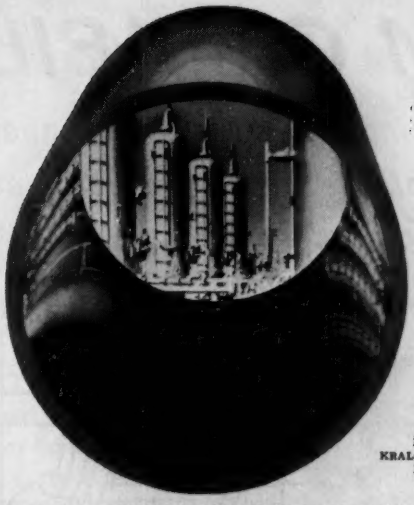

Its mirror-smooth interior walls enable KRALOY PVC PIPE to deliver 20% greater volume.

STOP PIPE CORROSION, CUT COSTLY MAINTENANCE WITH KRALOY PVC PLASTIC PIPE

Corrosive, crippling attacks of rust, most common acids, alkalis and hydrocarbon chemicals are mastered completely, quickly and economically by today's modern KRALOY PVC PLASTIC PIPE. Plant engineers, contractors, processors and industrial pipe users everywhere are turning to this versatile corrosion-proof pipe because they've found that KRALOY solves their toughest piping problems as no pipe of other material can. Amazingly light, (⅛ the weight of steel), rugged, high-impact KRALOY is easy to handle, simple to cut and join... saves up to 50% in installation costs, and *never needs painting.* KRALOY cuts downtime, and maintenance costs are negligible.

Not affected by electrolytic action, corrosion-proof KRALOY defies iron oxide deposits, sticky caustics, brine and scaling. Chemically inert, KRALOY PVC is impervious to phosphoric acid solutions, hydrofluoric and chromic acid fumes, and to corrosive splash. Precision extruded, mirror-smooth, free-flow KRALOY delivers up to 20% greater volume than same-size pipe of other material. Continuous rigid laboratory control insures unchanging KRALOY quality and long life of service. Available in all sizes from ¼" to 12" with plastic valves and fittings; also as U/L listed* electrical conduit in sizes ½" to 6".

*For direct underground burial, or encased in concrete.

KRALOY PLASTIC PIPE CO., INC., Dept. CHe-5
402 West Central Avenue, Santa Ana, Calif.

Please send me a copy of your FREE 36-page Technical Handbook on PVC Pipe.

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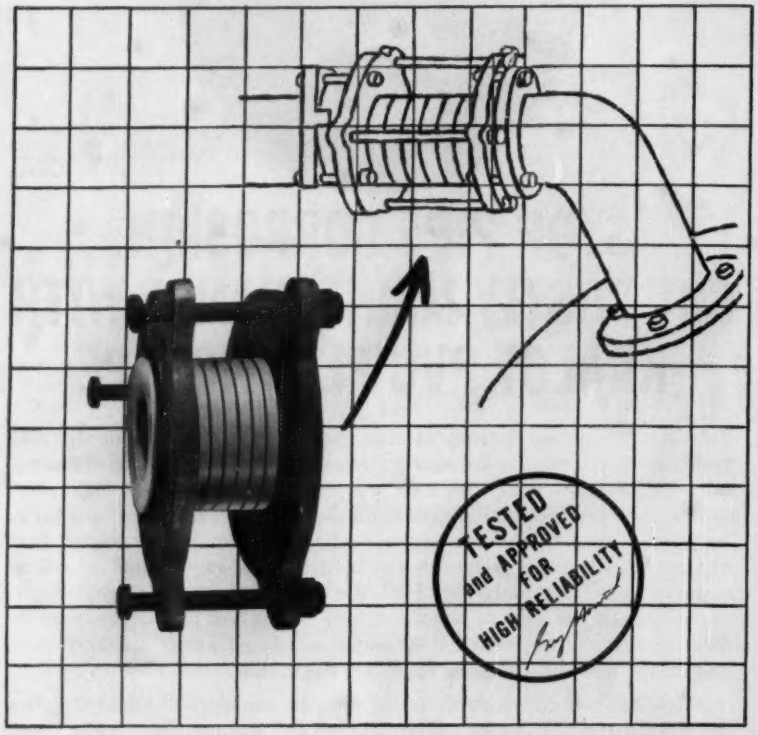
NOTHING PIPES LIKE KRALOY

SEE OUR CATALOG IN SWEET'S

Mail coupon today for KRALOY'S free 36-page Technical Handbook on PVC Pipe, packed with information, including flow charts and corrosion resistance chart covering more than 160 acids, as well as data on gases and other piping problems.

R/M CAPABILITY

in producing R/M Teflon Expansion Joints and Couplings helps protect glass pipe and associated equipment*



Consider using R/M Teflon Expansion Joints and Flexible Couplings for your piping. They absorb shock and vibration, compensate for angular misalignment, thermal expansion and contraction. They are impervious to industrial acids, caustics and solvents, will not absorb water, are not affected by weather, resist corrosion.

An outstanding feature of their construction is the convoluted design, which provides maximum movement. Machining to close tolerances with uniform wall thickness provides maximum resistance to fatigue and vibration. A special tie rod limit bolt arrangement prevents overexpansion of joints and breaking of pipes. Sizes range from 1 through 12 in. Standard ASTM cast iron flanges are used.

R/M, as a major producer of packings and gasket materials for industry, has the experience to help solve your toughest packing problems. Write for technical literature.

*Registered trademark for DuPont fluorocarbon resins

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RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

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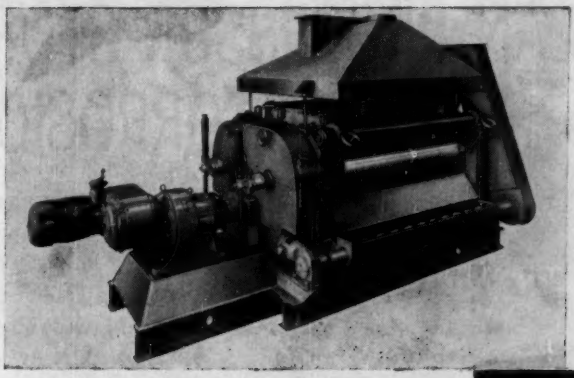


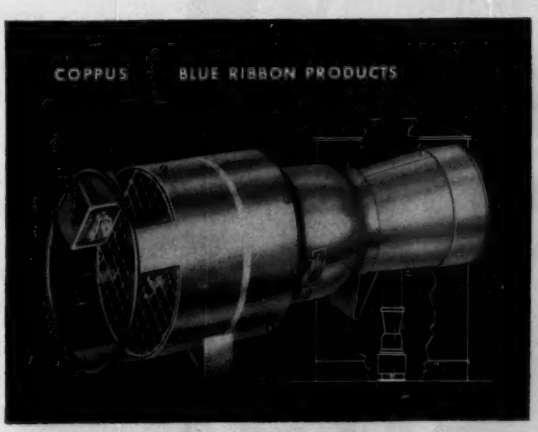
DAVENPORT Atmospheric Double Drum Dryer

Model 2-28-60 with several special features for drying a chemical compound. Drums are chrome plated and all other parts coming in contact with vapors or product are fabricated from stainless steel. Variable speed drive provides drum speeds of 1½ to 10 R.P.M.

Let our engineers consult with you on your Pressing, Drying and Cooling problems or send for our catalog "A". For quick reference consult your Chemical Engineering Catalog.

DAVENPORT MACHINE AND Foundry Company
Davenport, Iowa, U.S.A.

DAVENPORT
PRESSING – DRYING and COOLING Equipment
Continuous DeWatering Presses
ROTARY DRYERS
Steam Tube, Hot Air and Direct Fire
Atmospheric DRUM DRYERS
ROTARY COOLERS
Water and Air



COPPUS "Blue Ribbon" Ventilator-Blowers are portable and easily adaptable . . . for supplying fresh air or discharging foul air or fumes. Mail coupon below for facts.

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225 Park Avenue, Worcester 10, Mass.

- ☐ in tanks, tank cars
- ☐ in underground manholes
- ☐ for exhausting welding fumes
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- ☐ for general man cooling
- ☐ to stir up stagnant air wherever men are working or material is drying

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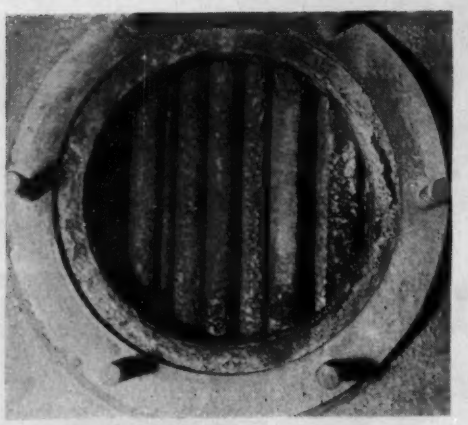
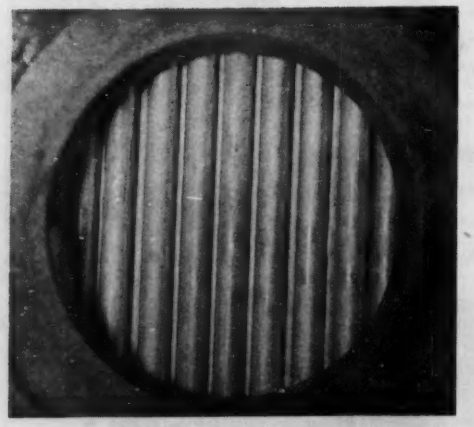
COPPUS BLOWERS

SOY BEAN PROCESSOR STOPS CONDENSER CORROSION WITH...



It was a modern, automatic, highly efficient plant. But steam, hexane vapors and amino acids did this to phosphorized admiralty tubing in the condensers after only two years. Oxidation (during shut-downs), vibration and thermal fatigue also took their toll. Red brass tubing was substituted. In two more years, the tubing failed again.

CARPENTER STAINLESS TUBING...



To find the answer, intensive corrosive tests were made on sample sections of red brass, admiralty, cupro-nickel, and several types of stainless tubing from different manufacturers. All tubing showed corrosion except Stainless Types 304 and 316. Carpenter Stainless 304 was finally selected because it was the least expensive of the two that held up.

EVEN AFTER FIVE YEARS!

After 5½ years of continuous service in the condensers, Carpenter Stainless 304 is as good as new and the soy bean processor "expects them to last indefinitely." Baffles, installed with original tubing, were no longer needed. Oxidation damage was stopped. Expensive plant shutdowns and costly maintenance were past history.

Dependable Carpenter Stainless Tubing is solving heat exchanger and corrosion problems like this for chemical processors coast to coast. For technical help or prompt mill stock delivery, call your Carpenter man today. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

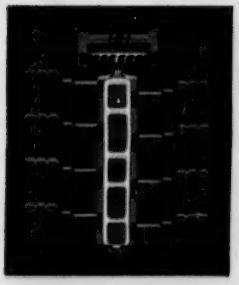
Steel

your master key to cost-saving corrosion control

Carpenter

Stainless Tubing & Pipe

WILL YOUR NEXT BALANCED OPPOSED COMPRESSOR HAVE ALL OF THESE "HIDDEN VALUES"?



No, it won't! Even if you choose a Worthington compressor, you'll get only 23 of the 24 "hidden values" pictured below. (Just to pique your interest one is fictitious. For identification of the phony feature, see page 200.)

Compressors should be evaluated on performance, we think you'll agree. But performance is determined by factors which aren't easily checked against service conditions and data. These are the factors we call "hidden values." It will pay you to evaluate these values the next time you specify a compressor. Worthington Corp., Clinton Street and Roberts Ave., Buffalo 5, N. Y. 36-8

WORTHINGTON

OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

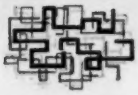
WIRE ALIGNMENT during assembly using electronic equipment minimizes field alignment problems.

FACTORY ASSEMBLY of intercooler and interstage piping reduces installation problems and costs.

COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.

HONING of connecting rod crankpin and crosshead pin ends results in tighter fits, no loose shells.

INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

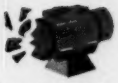


ANALOG/COMPUTER simulates wide range of actual operating conditions for optimum design analysis.

PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

KOLENE PROCESS removes impurities from bearing shell that weaken bond between it and babbitt.

FINISHED GROUND BEARING SHELLS provide positive full-contact backing for long life.



DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

REMOVABLE DOWEL locks piston rod to crosshead — prevents turning due to loosened crosshead nut.

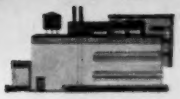
STEEL TIE BAR, keyed and bolted in place, strengthens frame and maintains the original alignment.

CROSSHEAD SLIPPER ADJUSTMENT within one-thousandth of an inch assures much longer packing life.

THERMODYNAMICS SECTION analyzes each application to size unit and determine its performance.

SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

ULTRASONIC TEST — an advanced method of examining certain critical parts for internal quality.



$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.

CAST-IN LUBE OIL SYSTEM with internally drilled oil passages eliminates crankcase "plumbing."

MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

FEATHER VALVE — industry's preferred compressor valve — is efficient, quiet, and low in maintenance.

ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.

AIR CONDITIONED GAUGE ROOM has master gauge blocks constantly used to check instruments.

FLUIDICS* AT WORK

Thread-on flange for F-C Glasteel Pipe is ASA 150# Series. Gasket features corrosion-resistant Teflon envelope at product contact area.

NOW

GLASTEEL pipe that you can field-cut

That's new Pfaudler F-C Glasteel pipe* you see being cut with a standard, dry abrasive cutoff wheel.

The F-C stands for "field cut." The pipe itself is steel on the outside for strength, glass on the inside for corrosion resistance. Once you've cut the length you want, you thread and then fire-polish with a small, portable furnace. (Furnace available from Pfaudler at a modest cost that you will completely recover through savings in a few installations.) You finish the pipe end with a belt sander to make sure that the gasket seat is flat and the flange connection seal-tight.

Glass lining for this new pipe is ⅛ inch thick, so you can expect substantially longer service life even with corrosive and/or abrasive fluids. Rated at 150 psi and available in 1½, 2 and 3 inch diameters, F-C pipe can be used with all acids (except HF) to 350° F. and with all mild alkalies at moderate temperatures.

Moreover, since glass is inert, you will also find this pipe useful for those products which must be kept free from contamination. And note, too, that because glass is smooth, there's little chance for build-up with sticky materials.

Aside from the fire-polishing furnace, you will find the tools needed for handling F-C Glasteel pipe in most plant maintenance shops. There is no need to engineer a piping layout to the last ⅛ inch. Installation and modification are easy, and very little maintenance is required.

As of now, you can get limited quantities from stock in lengths through 10 feet. For Bulletin No. 989 or for answers to specific questions on availability and delivery, please write to our Pfaudler Division, Dept. CEB-50, Rochester 3, N. Y.

*Patent applied for

FLUIDICS AROUND THE WORLD

Pfaudler Permutit is a world-wide company with manufacturing plants in: Germany, Great Britain, Canada, Mexico and Japan, as well as four plants in the U. S. A.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.